MCCOY

TECHNICAL MANUAL

HD9625

9-⅝” (24.4cm) 22K Lbs-Ft

Hydraulic Power Tong & FARR® Backup

- Specifications
- Commissioning
- Operation
- Maintenance
- Assembly

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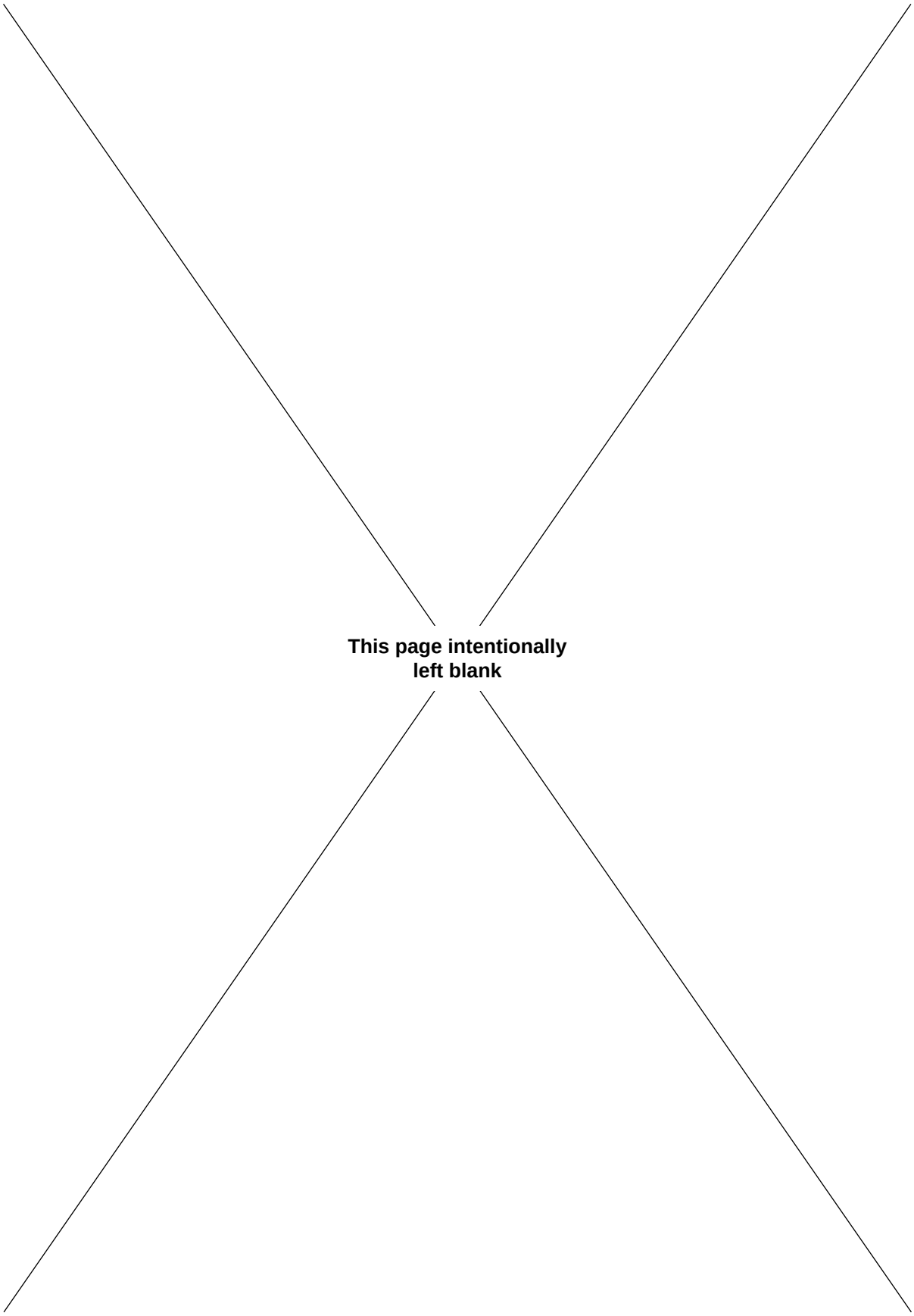
ORIGINAL INSTRUCTIONS

THIS TECHNICAL DOCUMENT APPLIES TO THE FOLLOWING MODELS:				
OVERALL MODEL	**TONG MODEL**	**BACKUP MODEL**	**REV**	**DESCRIPTION**
80-0831	80-0830-3	85-0627	4	9-⅝" 22K tong with two-speed hydraulic motor, motor valve, lift cylinder valve, backup valve, rigid sling, **FARR®** hydraulic backup, configured for compression load cell

McCoy has made an effort ensure that all illustrations are accurate, but please note that some illustrations used in this manual may not exactly visually match your equipment.

PATENTED & PATENTS PENDING



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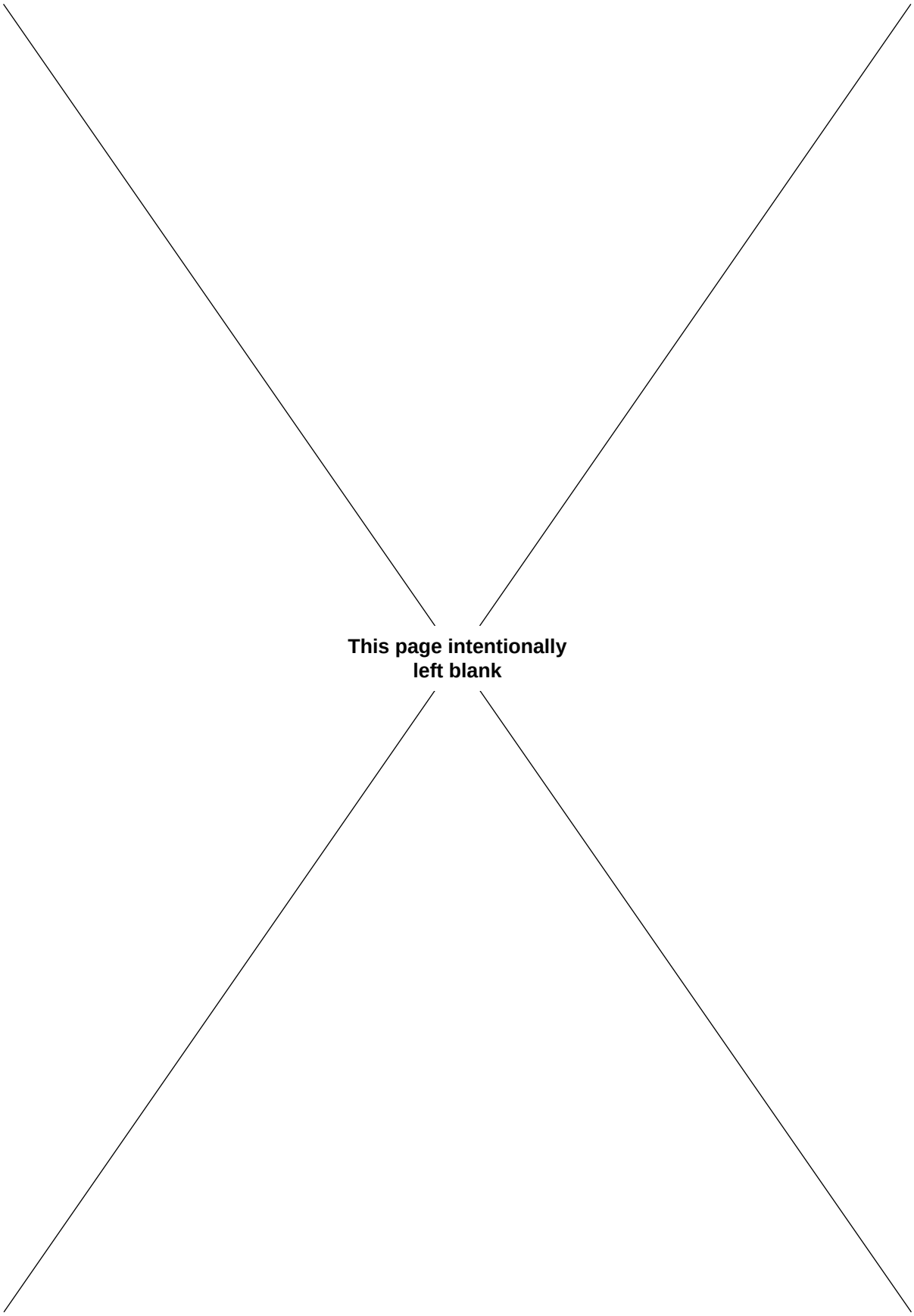
WARNINGS

A "LOAD-BEARING DEVICE" IS A CHAIN SLING, RIGID SLING, SPREADER BAR ASSEMBLY, FRAME, OR ANY OTHER DEVICE THAT BEARS THE PARTIAL OR TOTAL WEIGHT OF THE EQUIPMENT FOR WHICH THIS MANUAL HAS BEEN PRODUCED

THE LOAD-BEARING DEVICE SUPPLIED BY MCCOY DRILLING & COMPLETIONS IS DESIGNED TO SUPPORT THE EQUIPMENT DESCRIBED IN THIS MANUAL. MCCOY DRILLING & COMPLETIONS WILL NOT GUARANTEE THE ABILITY OF THE LOAD-BEARING DEVICE TO SUPPORT ANY OTHER PART, ASSEMBLY OR COMBINATION OF PARTS AND ASSEMBLIES. MCCOY DRILLING & COMPLETIONS WILL NOT GUARANTEE THE ABILITY OF THE LOAD-BEARING DEVICE TO LIFT OR SUPPORT THE EQUIPMENT DESCRIBED IN THIS MANUAL IF THERE ARE ANY MODIFICATIONS TO THE LOAD-BEARING DEVICE, OR ANY ADDITIONS TO THE EQUIPMENT DESCRIBED IN THIS MANUAL THAT ADD WEIGHT TO THE EQUIPMENT, UNLESS SUPPLIED BY MCCOY DRILLING & COMPLETIONS.

WHEN RE-ASSEMBLING LOAD-BEARING DEVICES (CHAIN SLINGS, RIGID SLINGS, BACKUP LEGS, ETC.) NOTE THAT THE ASSOCIATED FASTENERS MUST BE TIGHTENED TO THE CORRECT TORQUE SPECIFIED FOR THAT SIZE OF FASTENER (SEE SECTION 3 - OVERHAUL). ANY THREADED FASTENER IN A LOAD-BEARING DEVICE MUST BE SECURED WITH RED OR BLUE LOCTITE™.

ANY REPLACEMENT FASTENER (BOLTS, NUTS, CAP SCREWS, MACHINE SCREWS, ETC.) USED DURING MAINTENANCE OR OVERHAUL MUST BE GRADE 8 OR EQUIVALENT UNLESS OTHERWISE SPECIFIED.



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McCoy Drilling & Completions has made every effort to ensure the information contained in this document is accurate and current. This manual is intended to provide equipment operation and safety instructions for your equipment. However, McCoy Drilling & Completions does not warrant or guarantee that the information is either complete or accurate in every respect, and the user of the manual shall protect, indemnify, and hold harmless McCoy Drilling & Completions and all their directors, officers, employees, and agents from and against all liability for personal injury, death, or property damage resulting directly or indirectly from the use of the information contained in this manual.

Observance of all descriptions, information and instructions set out in this manual is the full responsibility of the user. This manual is intended for guidance and informational purposes and must be used in association with adequate training and on-the-job supervision to provide safe and effective equipment use.

It is the responsibility of the user to conform to all regulations and requirements issued by an authority or agency which may affect the operation, safety or equipment integrity, that may overrule the content of this documentation.

The user will acknowledge and obey any general legal or other mandatory regulation in force relating to accident prevention, safety, and equipment integrity.

Summary Of Revisions				
Date	**Section**	**Page**	**Description Of Revision**	**Approved**
FEB 2011	N/A	N/A	Initial Release	S. Hargreaves
FEB 2012	All	All	Updated branding & format to comply with current standards	S. Hargreaves
	1	1.3	Revised specifications	
	2	2.17	Inserted new sub-section 2.G.1. Operator Training	
	3	3.9-3.12	Revised sub-section 3.E.3 to include adjustment procedures for the next-generation safety door.	
	5	5.4	Corrected exploded view of rotary idler assembly	
	5	5.18-5.19	Replaced illustration and B.O.M. with revised version of hydraulic valve supports.	
	5	5.26-5.27	Inserted new illustration & B.O.M., Tong Door With New Safety Door Components	
	5	5.31	Revised “Leg Assemblies” B.O.M. to reflect part# change to item “F”.	
NOV 2013	All	All	Re-branded KT9625 to HD9625	R. Rahman
	1	1.4	Updated illustration 1.A.2, Overall Dimensions	
		1.5	Inserted new illustration 1.A.3, Additional hazard areas	
		1.6	Revised specs to reflect new torque capabilities	
		1.6	Revised lubricant standards	
	2	2.3	Inserted new section 2.A, Initial Receipt and Inspection of Equipment	
		2.3	Updated all illustrations Section 2.B, Major Component Identification	
		2.6	Moved and renumbered section "Sling/Load-Bearing Device Safety as Section 2.C.	
		2.9	Inserted new Section 2.D, Lift Cylinder Installation	
		2.12	Renumbered "Hydraulics" as Section 2.E	
		2.13	Moved "Hydraulic Component Identification" to "Hydraulics" section, numbered 2.E.2	
		2.15	Moved "Hydraulic Connections" in to "Hydraulics" section, numbered 2.E.3	
		2.16	Inserted new subsection 2.E.4, "Hydraulic Circuit Description".	
		2.17	Revised Section Tong/Backup Jaw Availability & Installation. Renumbered as Section 2.F	
		2.18	Renumbered "Tong Rig-Up & Leveling" as Section 2.G	
	3	All	Created new Section 3, Operation	
		3.3	Inserted new subsection 3.A.1, "Operator Training"	
		3.3	Inserted new subsection 3.A.2, "Operator Safety"	
		3.6	Updated illustration 3.A.5 "Tong Manual Shift Control".	
		3.6	Inserted new subsection 3.A.5, "Pre-Operational Checks"	

Continued on next page...

Summary Of Revisions (Continued):				
Date	**Section**	**Page**	**Description Of Revision**	**Approved**
NOV 2013	3	3.8	Updated illustration 3.B.1 "Master Lifting Link"	R. Rahman
	4		Renumbered "Maintenance" as Section 4	
		4.4	Inserted new Section 4.D "Hydraulic System Depressurization"	
		4.4	Renumbered "Lubrication Instructions" as Section 4.E	
		4.4 - 4.9	Updated all illustrations in Section 4.E, Lubrication Instructions	
		4.10	Renumbered "Adjustments" as Section 4.F	
		4.10	Updated illustration 4.F.1 "Brake Band Adjustment"	
		4.10	Updated illustration 4.F.2 "Shifter Detent Force Adjustment"	
		4.11	Revised subsection 4.F.3 "Safety Door Switch Adjustment" to reflect changes to safety door system	
		4.12	Renumbered "Recommended Periodic Checks" as Section 4.G	
		4.13	Renumbered "Removal of Top Plate for Overhaul" as Section 4.H	
		4.15	Revised "Assembly Instructions" to reflect engineering changes and new part numbers. Renumbered as Section 4.I	
		4.26	Renumbered "Daily Power Tong Inspection & Maintenance Checklist" as Section 4.J	
		4.28	Renumbered "Monthly Power Tong Inspection & Maintenance Checklist" as Section 4.K	
			Removed "Power Unit Daily Inspection and Maintenance Checklist"	
		4.31	Revised "Tubular Connection Equipment De-Commissioning & Shipping" to include packaging and shipping instructions. Renumbered as Section 4.L.	
		4.36	Renumbered "Tubular Connection Equipment Re-commissioning" as Section 4.M	
	5		Renumbered "Troubleshooting" as Section 5	
		5.4	Inserted new section 5.B "Relief Valve is Incorrectly Set or Malfunctioning"	
		5.6	Inserted new section 5.C "Safety Door Does Not Operate or is Malfunctioning"	
	6		Renumbered "Parts & Assemblies" as Section 6	
		6.2	Inserted "Critical Spare Parts" list	
		6.3	Inserted "Recommended (One-Year) Spare Parts" list	
		6.5	Inserted "Parts Required For Overhaul" list	
		6.18-6.19	Replaced manual shifter illustrations & updated B.O.M.	
		6.20-6.21	Replaced cage plate illustrations & updated B.O.M.	
		6.22-6.23	Replaced tong body illustrations & updated B.O.M.	
		6.30-6.31	Replaced door illustrations & updated B.O.M.	
		6.34-6.35	Replaced leg assembly illustrations & updated B.O.M.	
		6.36-6.37	Replaced backup body illustrations & updated B.O.M.	
		6.38-6.39	Replaced backup clamping section illustrations & updated B.O.M.	
	7		Renumbered "Torque Measurement" as Section 7	
		7.4	Updated torque measurement component part numbers	
			Removed tension load cell illustrations	
		7.7	Revised Section 7.B "Troubleshooting"	
		7.8	Revised Section 7.C "Periodic Inspection & Maintenance"	
		7.8	Inserted subsection 7.C.3 "Reference Checking Your Torque Measurement System"	
	8		Renumbered "OEM Documentation" as Section 8	

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The information presented in this document will provide setup, operating, and maintenance instructions for your HD9625 tong. Due to the wide variety of operating conditions, these instructions must be considered guidelines rather than absolute operating procedures. It is the responsibility of the user to use these guidelines together with an experienced manager to develop operating procedures that conform to all policies set forth by the operating authority (ies).

IDENTIFICATION OF OF WARNINGS AND OTHER NOMENCLATURE OF IMPORTANCE USED IN THIS INSTALLATION GUIDE

McCoy Drilling & Completions | FARR uses three indicators to describe items of three degrees of importance.

A **HAZARD** to operators or equipment is represented by an exclamation point within a red triangle and identifies items of the highest importance. Failure to heed information identified by a **HAZARD** symbol may result in bodily injury, death, catastrophic equipment damage, or any combination of these. A **HAZARD** may also indicate the potential for dangerous environmental contamination.

This identifies a HAZARD to operators or equipment

A **WARNING** is represented by an exclamation point within an orange triangle, and contains information that will alert personnel to a potential safety hazard that is not life-threatening. A **WARNING** may also serve to alert the user to information critical to the correct assembly or operation of the equipment in use.

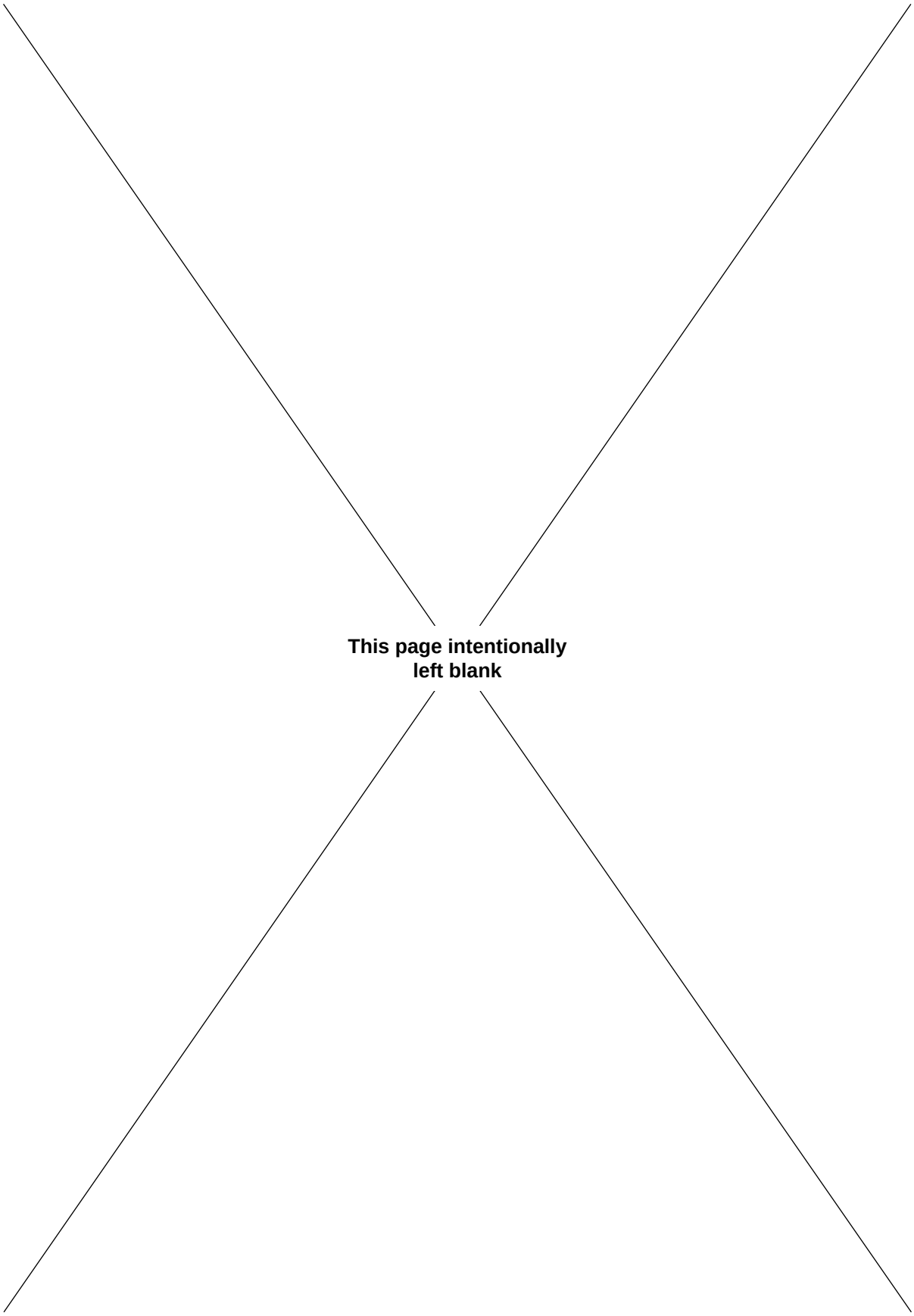
This identifies a WARNING to users

A **CAUTION** is represented by an exclamation point within a yellow triangle and highlights information that may aid the user during assembly or operation of your equipment. **CAUTIONs** are also used to ensure common errors are not made during assembly or operation of your equipment.

This identifies a CAUTION to users

Observance of the following is the full responsibility of the user:

- **all descriptions, information and instructions set out in this manual**
- **any regulation or requirement issued by an authority or agency which may influence operation, safety or integrity of the equipment that overrules the content of this document.**
- **any legal or other mandatory regulation in force governing accident prevention or environmental protection.**



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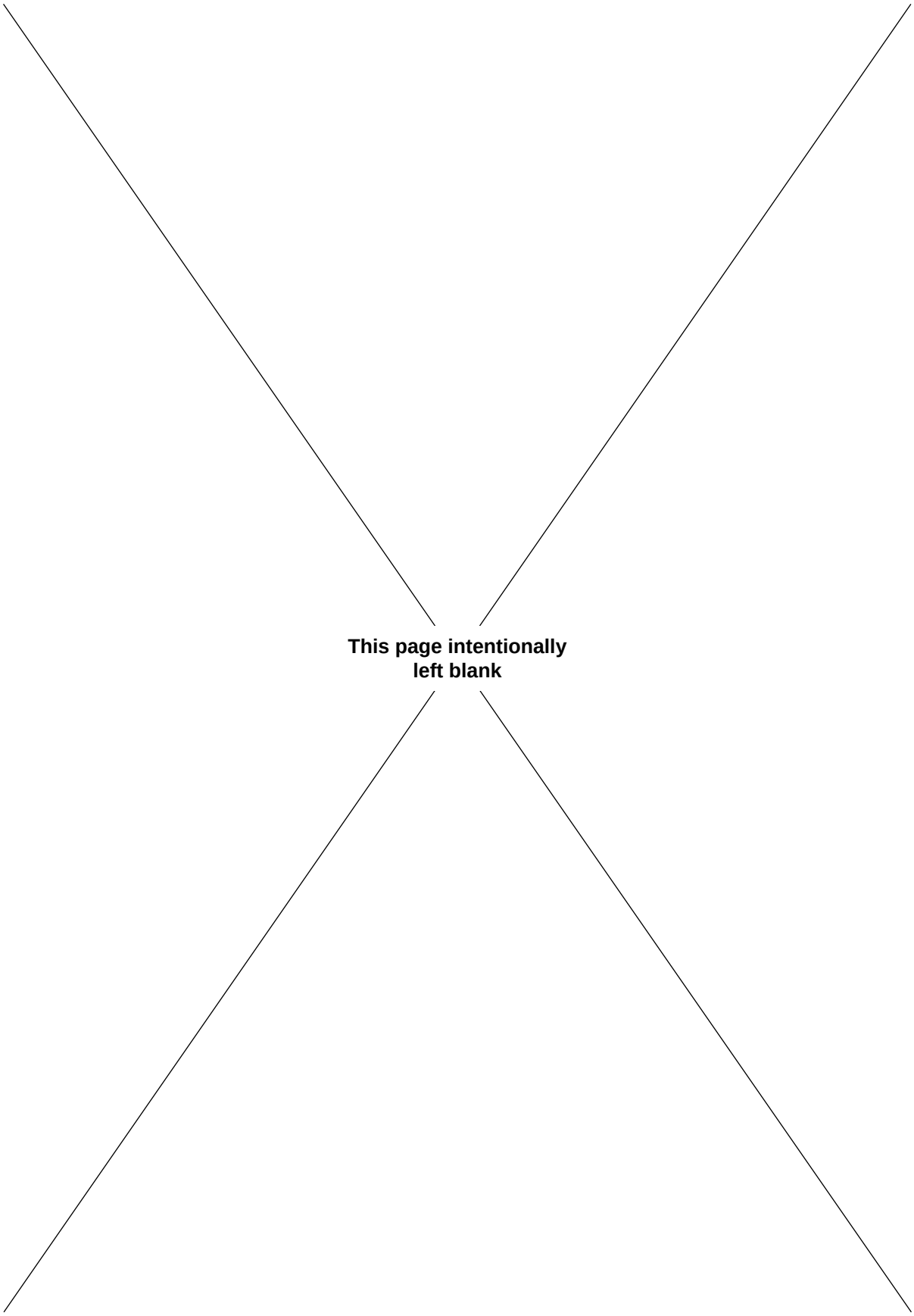
MCCOY | DRILLING & COMPLETIONS

MOVING GLOBAL ENERGY FORWARD

SECTION 1: INTRODUCTION & SPECIFICATIONS



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Congratulations on the purchase of your **FARR**® HD9625 9-⅝" heavy-duty tong and **FARR**® hydraulic backup. This unit will provide you with years of outstanding performance. Simple maintenance and care will extend its life and ensure years of excellent performance and reliability. The setup, operating, and maintenance instructions in this manual will assist you in giving your equipment the care it requires. Please carefully read the manual before installing and using your equipment. Replacement parts are readily available from McCoy Drilling & Completions | FARR in Edmonton, Alberta. Note that many parts are transferable between **FARR**® tongs and backups. Should you need replacement parts, or should you experience any difficulty not covered in this manual, please contact:

McCoy Drilling & Completions | FARR

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Edmonton, Alberta
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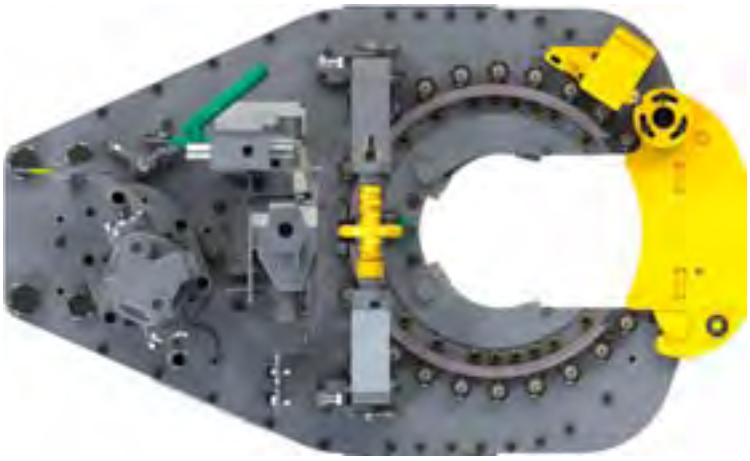
Website: http://www.mccoyglobal.com/drilling-completions

ILLUSTRATION 1.A.1: KT9625 POWER TONG & "FARR-STYLE" BACKUP



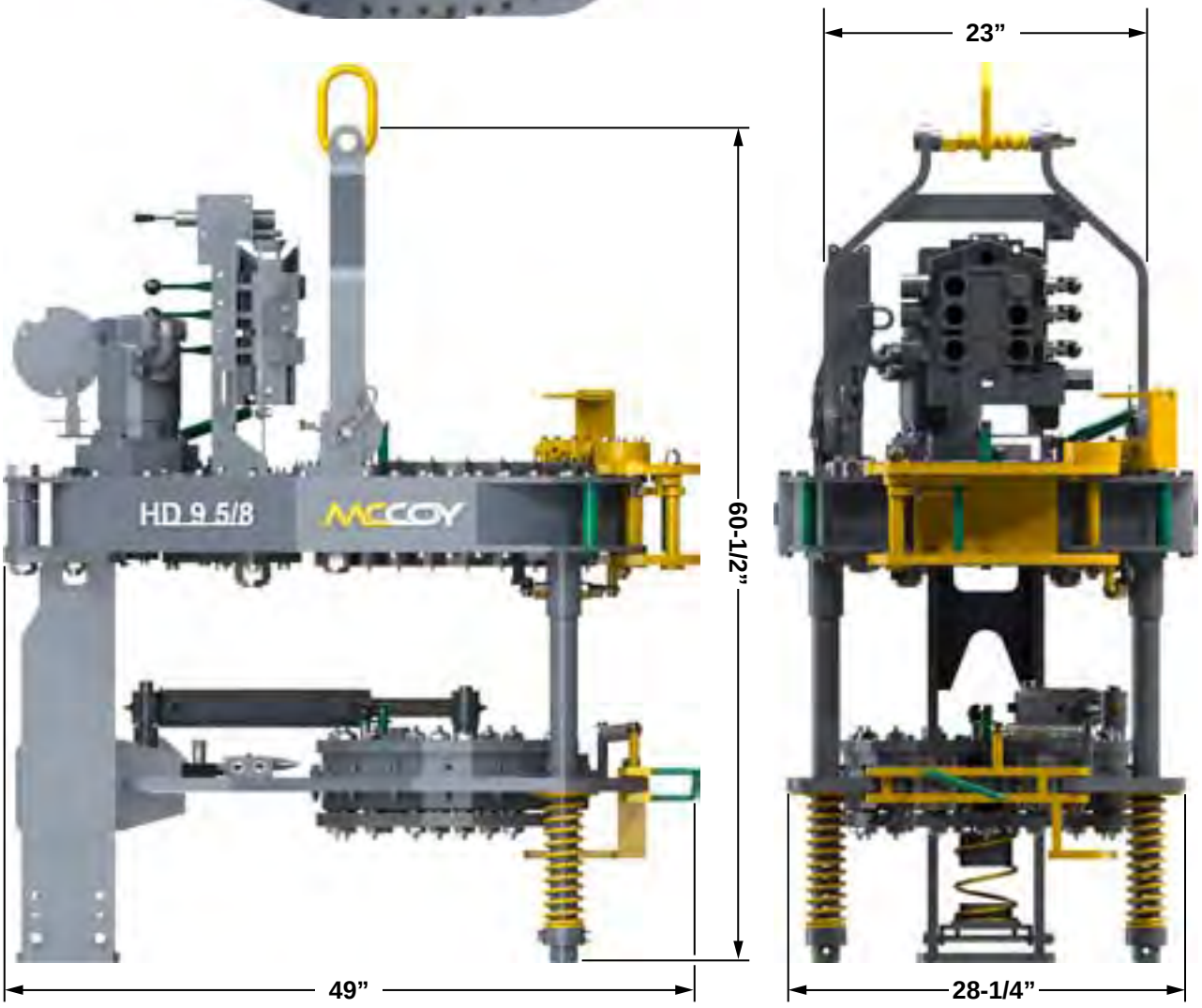


Illustration 1.A.2: HD9625+FBU Dimensions

REPLACEMENT FASTENERS (BOLTS, NUTS, CAP SCREWS, MACHINE SCREWS, ETC.) MUST BE GRADE 8 OR EQUIVALENT UNLESS OTHERWISE SPECIFIED

In addition to the **HAZARD** areas of this equipment that are coated **YELLOW**, a rotating cage plate assembly and backup clamp cylinders pose significant hazards when the equipment is active. Keep hands clear of the cage plate and backup clamp cylinders when equipment is energized. **SAFE** areas to handle while the equipment is energized are indicated by **GREEN** coating

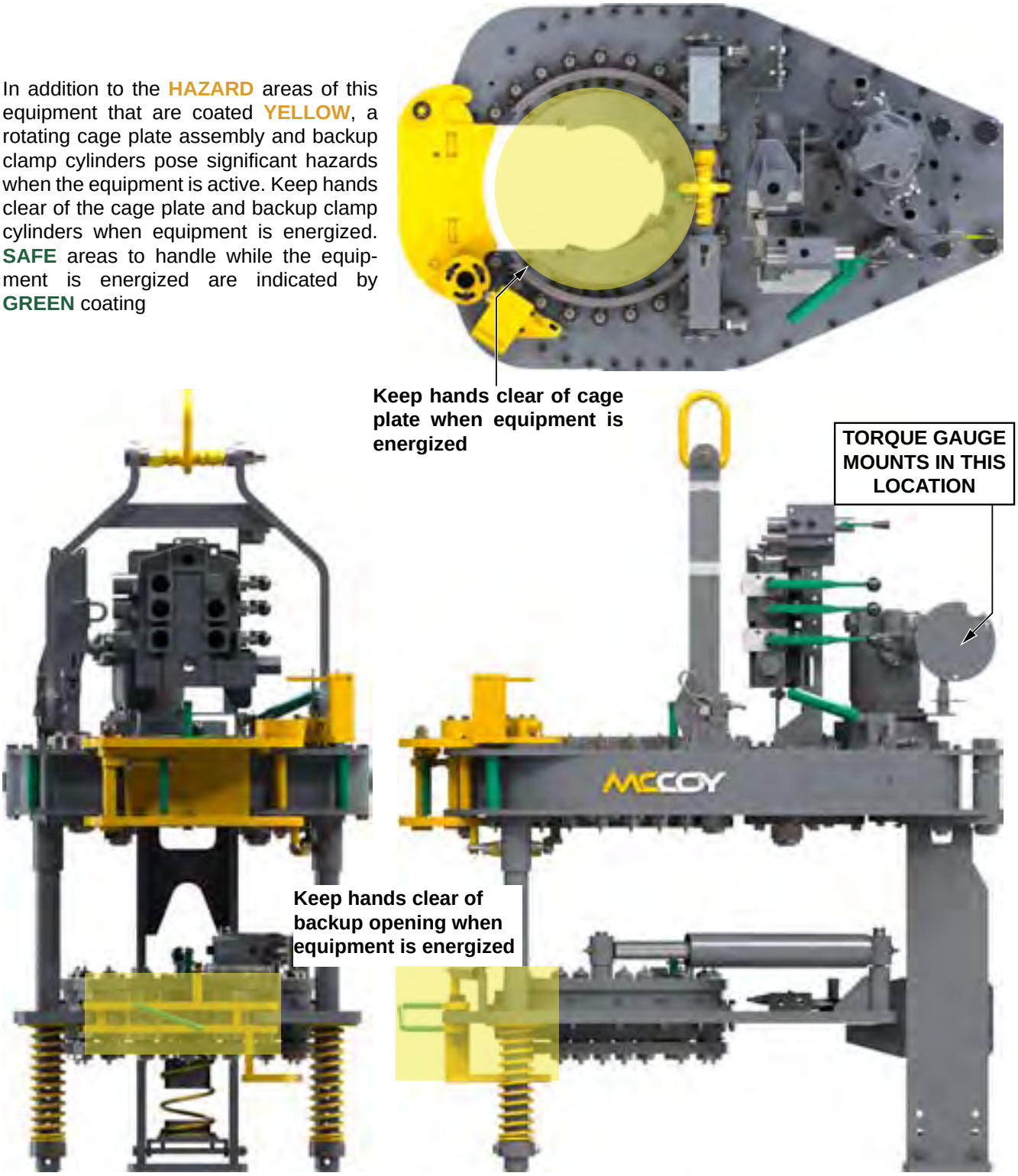

Keep hands clear of cage plate when equipment is energized
TORQUE GAUGE MOUNTS IN THIS LOCATION
Keep hands clear of backup opening when equipment is energized
MCCOY

ILLUSTRATION 1.A.3: HD9625 TONG & FARR® BACKUP HAZARD AREAS

Torque Table

Please note that these are ideal values. Actual achieved torque is highly dependant upon tong efficiency and final position of rotary gear when full torque load is reached. Maximum torque is only available in low gear and full motor displacement.

Pressure	High Speed (Half Displacement)				Low Speed (Full Displacement)			
	Gear				Gear			
	HI		LO		HI		LO	
PSI / MPa	Lbs.-ft.	Nm	Lbs.-ft.	Nm	Lbs.-ft.	Nm	Lbs.-ft.	Nm
1000 / 6.895	800	1085	4000	5423	1600	2169	8000	10847
1500 / 10.34	1300	1763	6500	8813	2600	3525	12900	17490
2000 / 13.79	1800	2440	9000	12202	3500	4745	17900	24269
2410 / 16.62	2200	2983	11000	14914	4300	5830	22000	29823
MAXIMUM RATED TORQUE: 22000 LBS.-FT. / 29823 Nm								
MAXIMUM SYSTEM PRESSURE: 2410 PSI / 16.616 MPa								

Speed Table

	Gear / Displacement			
Flow (GPM/LPM)	Low/Full	Low/Half	High/Full	High/Half
10 / 37.9	2	5	12	24
20 / 75.7	5	9	24	47
40 / 151.4	9	18	47	95
60 / 227.1	14	28	71	142

Maximum Hydraulic Requirements	60 GPM (227.1 LPM)
	2500 PSI (17.237 MPa)
Maximum Dimensions:	
Length (Door Closed)	49 inches / 101.6 cm
Height	60-½ inches / 153.7 cm
Width	30 inches / 76.2 cm
Maximum Elevator Diameter	Unlimited (tong comes off pipe)
Space Required On Pipe	8 inches / 20.32 cm
Torque Arm Length (Pipe center to anchor center)	28" / 71.1 cm
Dead Weight (Approximate)	1700 lbs / 773 kg (jaws not included)
Maximum Allowable Rigid Sling Load	2500 lbs / 1136.4 kg
Sound Level (dBa)	97 dB A @ 1m / 96 dB C @ 1m
Jaws available (inches)	All standard sizes from 2-⅞" to 9-⅝" (See Pg. 2.17)
Recommended Spring Hanger	85-0106XXH (Max Capacity = 2400 lbs / 1091 kg)

ONLY USE SPRING HANGER SUPPLIED BY MCCOY. IF USING SPRING HANGER REFER TO SECTIONS 2.D & 2.G FOR PROPER RIGGING INSTRUCTIONS.

Lubricant Standards:

McCoy recommends using good-quality hydraulic fluid with a viscosity of ISO 68. Allowing adequate time for the hydraulic fluid to reach an operating temperature of 38°C to 48°C (100°F to 118°F) permits the fluid to operate at its optimum operating viscosity, and maximizes the service life of the fluid and integrity of hydraulic components. System temperature above 54°C (130°F) exceeds the temperature that allows minimum operating viscosity of the fluid. Running your hydraulic system at temperatures continuously exceeding 60°C (140°F) will lead to premature component wear, leaking seals, slow hydraulic system response, and more frequent replacement of the hydraulic fluid. A hydraulic fluid cooler is recommended where operating temperatures are expected to exceed the recommended maximum.

McCoy recommends use of a good-quality EP synthetic multi-purpose grease with an NLGI consistency grade of "2" and an NLGI performance grade of "GC-LB" for general lubrication of bearings and metal-to-metal contact.

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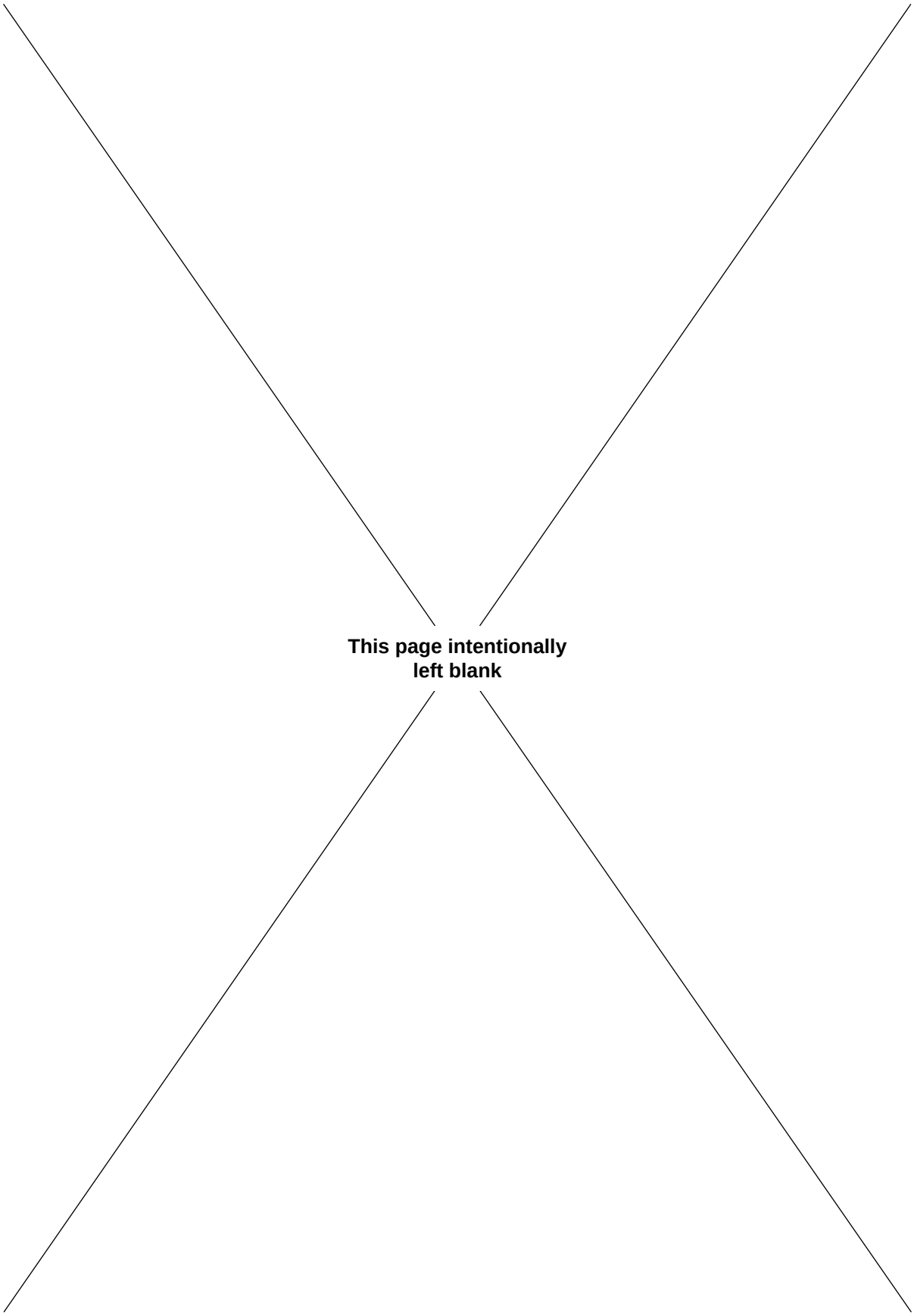
SECTION 2: INSTALLATION & COMMISSIONING



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Adequate setup and proper hydraulic connections are essential in ensuring reliable operation of your McCoy mechanical roughneck. For best results and long term reliability, read and obey the installation and commissioning instructions in this section.

2.A INITIAL RECEIPT AND INSPECTION OF EQUIPMENT

YOUR EQUIPMENT HAS BEEN THOROUGHLY TESTED AND INSPECTED AT THE FACTORY. HOWEVER, MCCOY ADVISES INSPECTING YOUR EQUIPMENT FOR SHIPPING DAMAGE UPON RECEIPT AND TESTING YOUR EQUIPMENT BEFORE RELEASING TO AN OPERATIONAL ENVIRONMENT.

Perform a visual inspection following removal of all packaging material. Immediately identify any shipping damage to the shipping company, and correct all damage before connecting equipment to a hydraulic power source.

2.B MAJOR COMPONENT IDENTIFICATION

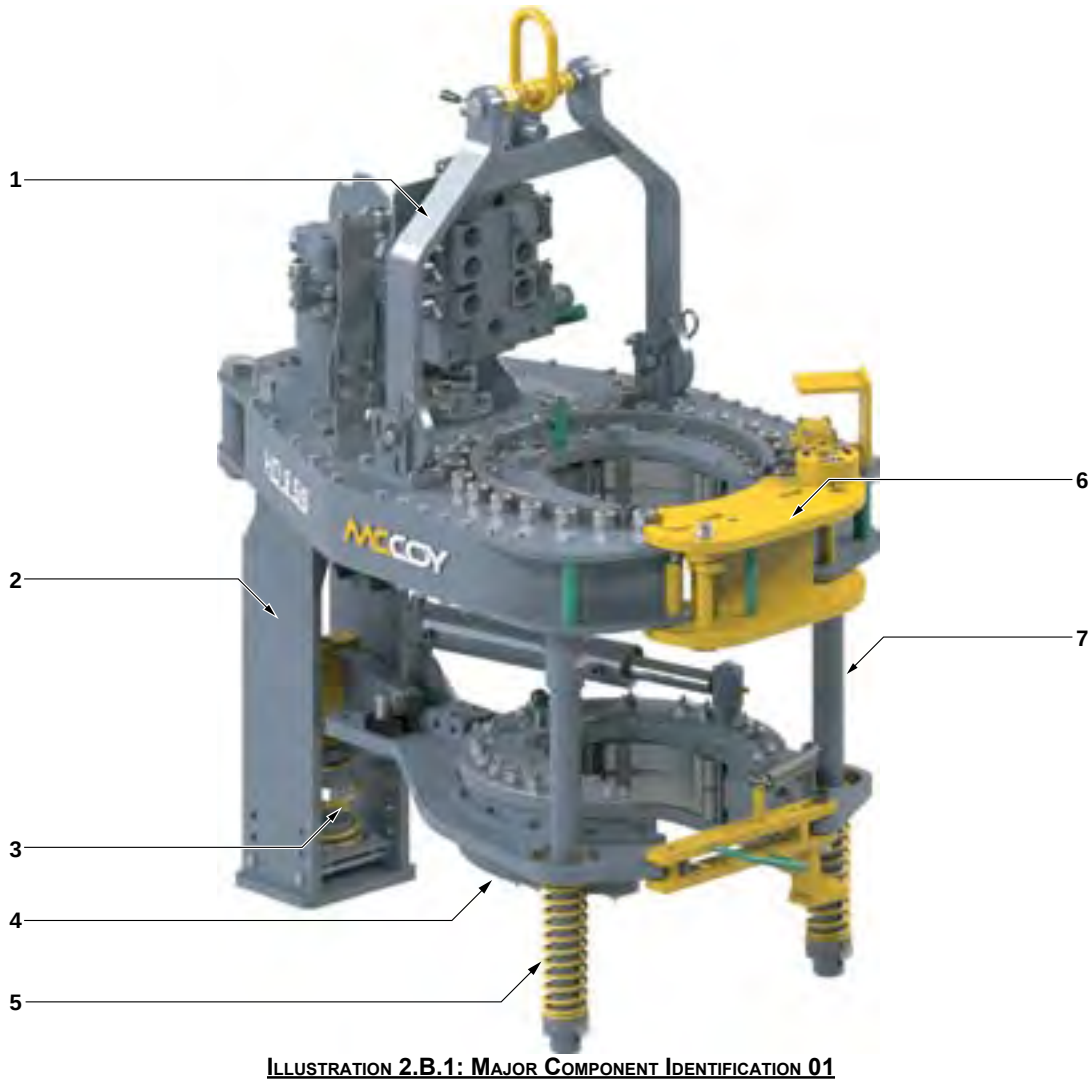

ILLUSTRATION 2.B.1: MAJOR COMPONENT IDENTIFICATION 01

Item	Description
1	Rigid sling
2	Rear leg
3	Rear leg spring assembly
4	Backup
5	Front leg spring
6	Tong door
7	Front leg assembly

Illustration 2.B.2: Major Component Identification 02

Item	Description
8	Hydraulic motor
9	Motor mount
10	Tong leveling device
11	Cage plate
12	Hydraulic valve assembly
13	Backing pin assembly
14	Safety door (rotation interlock) components
15	Tong jaw with die inserts
16	Tong door latch

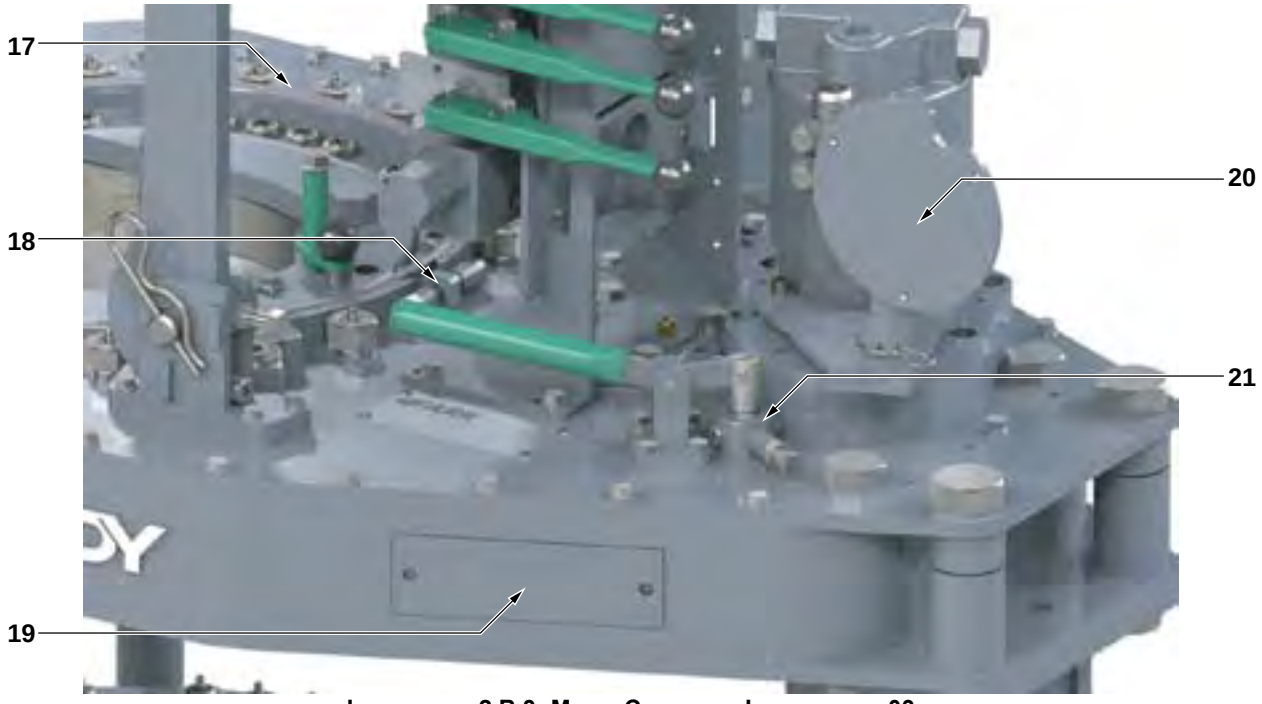

ILLUSTRATION 2.B.3: MAJOR COMPONENT IDENTIFICATION 03

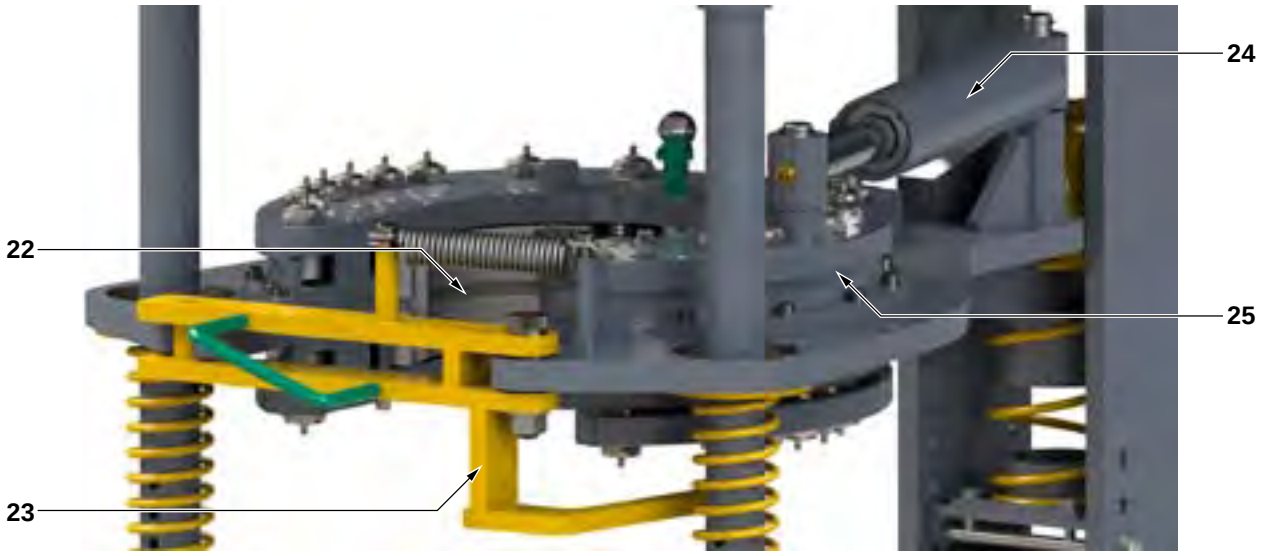

ILLUSTRATION 2.B.4: MAJOR COMPONENT IDENTIFICATION 04

Item	Description
17	Brake band
18	Brake band adjustment
19	Clutch / shifter access panel
20	Torque gauge mount
21	Manual shifter
22	Backup jaw with die inserts
23	Backup door
24	Backup clamp cylinder
25	Backup rotary section

2.C SLING / LOAD BEARING DEVICE SAFETY

THE SUPPLIED LOAD-BEARING DEVICE (CHAIN SLING, RIGID SLING, SPREADER BAR ASSEMBLY, FRAME, OR ANY OTHER DEVICE THAT BEARS THE PARTIAL OR TOTAL WEIGHT OF THE EQUIPMENT DESCRIBED IN THIS MANUAL) HAS BEEN SPECIFIED OR DESIGNED TO SUPPORT THE EQUIPMENT DESCRIBED IN THIS DOCUMENT. FARR® WILL NOT GUARANTEE THE ABILITY OF THE LOAD-BEARING DEVICE TO SUPPORT ANY OTHER PART, ASSEMBLY OR COMBINATION OF PARTS AND ASSEMBLIES, OR ANY ADDITIONS TO THE EQUIPMENT DESCRIBED IN THIS MANUAL THAT ADD WEIGHT TO THE EQUIPMENT, UNLESS SUPPLIED BY MCCOY.

MCCOY DRILLING & COMPLETIONS DOES NOT GUARANTEE THE INTEGRITY OF MODIFIED OR DAMAGED LOAD-BEARING DEVICES, UNLESS THOSE MODIFICATIONS ARE PERFORMED BY MCCOY.

McCoy Drilling & Completions recommends following an industry-accepted standard such as OSHA, ASME B30.9-2006, or manufacturer's guidelines when performing any rigging and overhead lifting. Use by untrained persons is hazardous. Improper use will result in serious injury or death. Do not exceed rated capacity. Slings will fail if damaged, abused, misused, overused, or improperly maintained.

- Only grade 80 or grade 100 alloy chain should be used for overhead lifting applications.
- Working Load Limit (WLL) is the maximum allowable load in pounds which may be applied to the load-bearing device, when the device is new or in "as new" condition, and when the load is uniformly and directly applied. The WLL must never be exceeded.
- Working Load Limit (WLL) is the maximum working load for a specific minimum sling angle, measured from the horizontal plane. The Working Load Limit is identified on the sling.
- The Working Load Limit or Design factor may be affected by wear, misuse, overloading, corrosion, deformation, intentional alterations, sharp corner cutting action and other use conditions.
- Shock loading and extraordinary conditions must be taken into account when selecting alloy chain slings.
- See OSHA Regulation for Slings 1910.184, ANSI/ASME B30.9-"SLINGS", ANSI/ASME B30.10-"HOOKS" and ANSI/AMSE B30.26 "RIGGING HARDWARE" for additional information.

THE MINIMUM SLING ANGLE (THE ANGLE OF THE LEG OF THE SLING MEASURED FROM THE HORIZONTAL) MUST NEVER FALL LOWER THAN THE ANGLE SPECIFIED FOR THE SLING IN USE

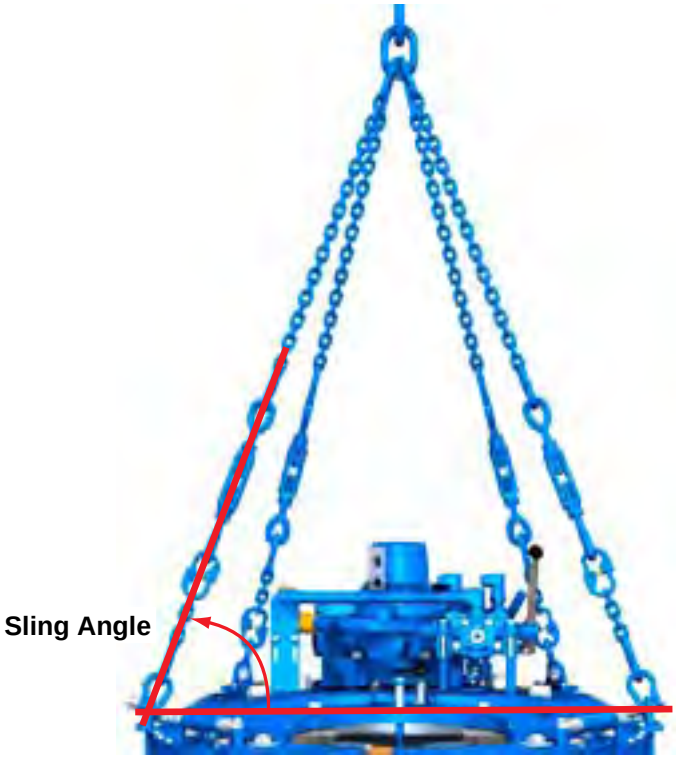

Illustration 2.C.1: Sling Angle

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2.C.1 Inspection Of Slings

Farr strongly recommends the following practices:

A complete inspection of new load-bearing devices and attachments shall be performed by a qualified, designated person prior to initial use. Each link and component shall be examined individually, taking care to expose and examine all surfaces including the inner link surface. The sling shall be examined for conditions such as those listed in the removal criteria below. In addition, daily inspection of slings, fastenings and attachments shall be performed by a designated person. If damage or defects are found at either inspection, the damaged or defective component shall be quarantined from service until it can be properly repaired or replaced.

Removal Criteria:

A load-bearing device shall be removed from service if conditions such as the following are present:

- Missing or illegible sling identification.
- Cracks or breaks
- Evidence of tampering is seen - sling tag has been modified or obscured, or tamper-proof nuts are missing.
- Signs of impact on load-bearing components, including spreader bars, lifting lugs, rigid slings & rigid sling weldments, and legs & leg mounts.
- Broken or damaged welds.
- Excessive wear, nicks, or gouges. Refer to the chart below to ensure minimum thickness on chain links supplied is not be below the values listed:

Minimum Allowable Chain Link Thickness at Any Point			
Nominal Chain Size		**Minimum Thickness**	
Inches	MM	Inches	MM
7/32	5.5	0.189	4.80
9/32	7	0.239	6.07
5/16	8	0.273	6.93
3/8	10	0.342	8.69
1/2	13	0.443	11.26
5/8	16	0.546	13.87
3/4	20	0.687	17.45
7/8	22	0.750	19.05
1	26	0.887	22.53
1-1/4	32	1.091	27.71
Refer To ASME B30.9			

- Stretched, bent, twisted, or deformed chain links or components.
- Evidence of heat damage.
- Excessive pitting or corrosion.
- Lack of ability of chain or components to hinge (articulate) freely.
- Weld splatter.
- For hooks, removal criteria as stated in ASME B30.10
- Other conditions, including visible damage, that cause doubt as to the continued use of the sling.

Inspect all lugs and fixing points for signs of elongation and/or bending, or for material build-up around the hole. Repair or replace components that appear distorted. Ensure all hardware is tight and in good condition. Replace missing hardware if necessary. All hardware must be free of rust and corrosion.

Additional inspections shall be performed during sling use where service conditions warrant. Periodic inspection intervals shall not exceed one year. The frequency of periodic inspections should be based on:

- Frequency of use of the load-bearing device.
- Severity of service conditions
- Nature of lifts being made
- Experience gained on the service life of load-bearing devices used in similar circumstances.

Guidelines for the interval are:

- Normal Service - yearly
- Severe Service - monthly to quarterly
- Special Service - as recommended by a qualified person

Units designed and manufactured in accordance with EN 12079 and DNV 2.7-1 should be tested and examined in accordance with the following schedule of examination and test. The user of the load-bearing device shall place a permanent placard or plate upon which the type and date of the last test shall be recorded. To avoid confusion, the plate shall not carry the date of the next test or examination, only the most recent.

Test / Examination				
Time / Interval	Lifting Tests[1]	Non-Destructive Examination (NDE) of Lifting Points	Thorough Visual Examination	Suffix To Be Marked On Plate Attached To Unit
Initial Certification By McCoy	YES	YES	YES	T
Interval Not Exceeding 12 Months	At the discretion of inspection body	At the discretion of inspection body	YES	T or VN[3]
Interval Not Exceeding 60 Months	At the discretion of inspection body	YES	YES	T or VN
Following Substantial Repair or Alteration[4]	YES	YES	YES	T

1. Lifting test as per S 7.3 BS EN 12079 or DNV 2.7-1 May 1995
2. T = Proof Test, non-destructive examination; VN = non destructive examination and visual examination; V = visual examination.
3. Dependant upon whether non-destructive examination has been carried out.
4. For the purposes of this standard, a substantial repair or modification is defined as any repair and/or modification that has been carried out which may, in the opinion of the inspection body, affect the load-bearing elements of the container or lifting device, or elements that contribute directly to its structural integrity.

OBSERVED OR SUSPECTED MECHANICAL MECHANICAL DAMAGE TO A LOAD-BEARING DEVICE, OR OVERLOADING OF A THE LOAD-BEARING DEVICE HAS BEEN OVERLOADED REQUIRES REMOVAL FROM SERVICE AND QUARANTINING OF THE DEVICE UNTIL RECERTIFIED

Written records of the most recent periodic inspection shall be maintained, and shall include the condition of the sling.

2.C.2 Proper Use Of Load-Bearing Devices

Whenever any load-bearing device is used, the following practices shall be observed.

- Load-bearing devices that are damaged or defective shall not be used.
- Slings shall not be shortened with knots or bolts or other makeshift devices.
- Sling legs shall not be kinked.
- Load-bearing devices shall not be loaded in excess of their rated capacities.
- Slings shall be securely attached to their load.
- Load-bearing devices shall be protected from snagging, and shall not be further obstructed by any object.
- Suspended loads shall be kept clear of all obstruction.
- All employees shall be kept clear of loads about to be lifted and of suspended loads.
- Hands or fingers shall not be placed between the sling and its load while the sling is being tightened around the load.
- Shock loading is prohibited.
- Do not stand directly under a load during lifting.

2.C.3 Storage Of Load-Bearing Devices

Proper storage of out-of-service load bearing devices is important to ensure full integrity of the device once it is returned to service. Farr recommends observing the following practices.

- Wipe off all excess grease. Use a solvent-based cleaner on rags to wipe all external surfaces to remove residual grease or hydraulic fluid. Once the outside surfaces have been de-greased, wipe all external surfaces with clean water to remove residual solvent.
- Farr recommends that an anti-corrosive agent such as Tectyl® 506 be applied to all external surfaces. Refer to manufacturer data sheets for proper application and safety information. Allow the anti-corrosive coating ample time to dry - refer to manufacturer data sheets for drying times at room temperature.
- Store in a clean, dry location. When returning to service, note that a full inspection of the device must be performed.

2.D LIFT CYLINDER INSTALLATION

The lift cylinder is not orientation-specific; that is, the lift cylinder will function the same way independent of which end is connected to the crane and which end is connected to the main lifting lug of the tong (or the spring hanger, if used). However, McCoy recommends orienting the lift cylinder with the hydraulic hose connection at the bottom of the cylinder to ensure the hose is not stressed when cylinder is at full extension.

TEST LIFT CYLINDER BEFORE INSTALLATION. REFER TO THE LIFT CYLINDER TECHNICAL MANUAL FOR DETAILED TESTING AND OPERATING PROCEDURES, AND DETAILED SAFETY GUIDELINES.

ENSURE TO ACCOUNT FOR THE WEIGHT OF THE SPRING HANGER WHEN CALCULATING TOTAL SUSPENDED WEIGHT.

2.D.1 Installation Procedure

i. Use a crane to hoist the lift cylinder by the shackle, ensuring the hydraulic hose connection is at the bottom of the cylinder when it is hoisted.

ii. Remove the two R-clips securing the clevis pin, and remove the clevis pin.

iii. Orient the spring hanger so the piston will extend down during thread make-up, preventing water and debris from gathering around the seal.

iv. Place the welded U-connection inside the clevis. Replace the clevis pin, and secure the clevis pin with the two R-clips.

v. Hoist the lift cylinder and spring hanger.

vi. Place a 1" shackle around the master lifting link on the tong sling. Secure the shackle to the extending end of the spring hanger using the 1-1/8" UNC x 4-3/4" modified hex bolt and 1-1/8" UNC hex jam nut. Secure the jam nut to the bolt using a 3/16" x 1-1/4" cotter pin.

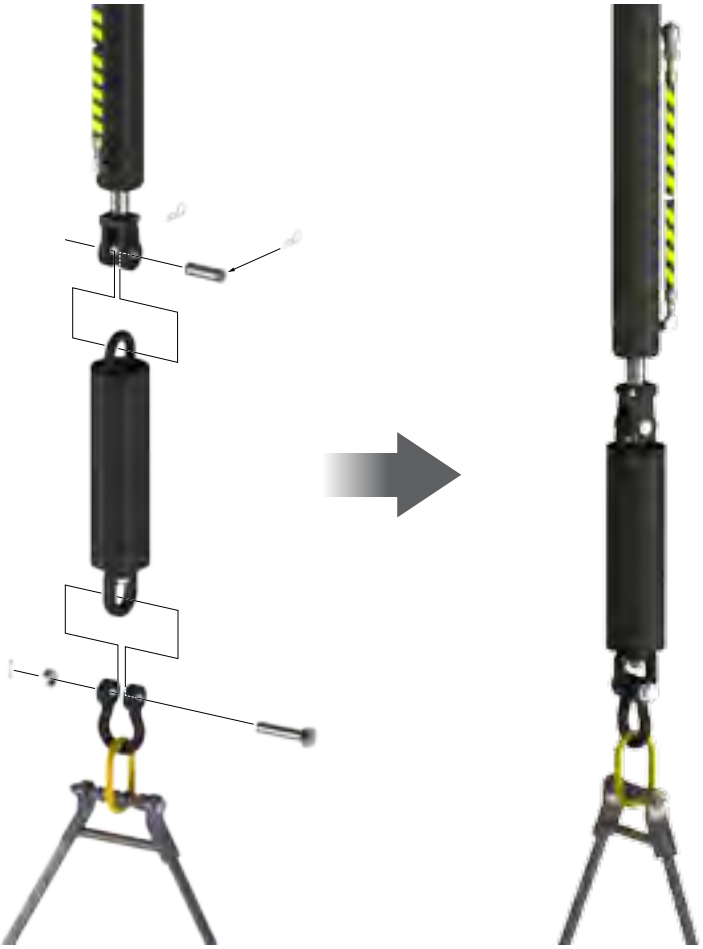


ILLUSTRATION 2.D.1: LIFT CYLINDER & SPRING HANGER INSTALLATION

2.D.2 Lift Cylinder Connection

Inspect the hydraulic hose before connection, ensuring the line is free of ruptures, cracks, cuts, or other damage. Inspect the female quick-connect fitting to ensure it is free from damage. Connect the female quick-connect on the lift cylinder hydraulic hose to the male quick-connect fitting attached to the needle valve on the tong valve bank. Once the fitting has snapped into place give the hydraulic line a light tug upwards to ensure the fitting is securely seated.

If not already done, connect the main hydraulic supply to the power tong (see section 2.F for proper hydraulic connection procedure). Energize the hydraulic supply to the power tong.

Lift the power tong approximately three inches off the work surface, and suspend the tong for approximately thirty seconds. Following the suspension alternately lift and lower the tong slightly to confirm that lift and lower functions each operate correctly.

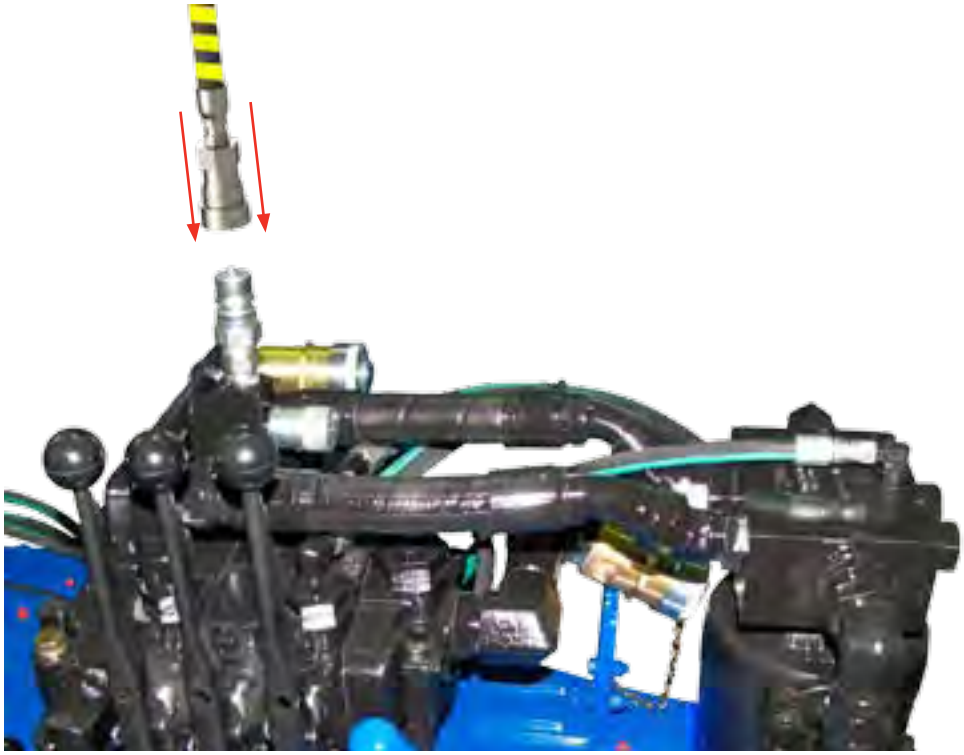


ILLUSTRATION 2.D.2: LIFT CYLINDER HYDRAULIC CONNECTION

2.D.3 Lift Cylinder Safety

A CLEARLY IDENTIFIED REMOTE POWER PACK EMERGENCY STOP MUST BE INSTALLED IN THE IMMEDIATE VICINITY OF THE TONG OPERATOR.

McCoy Drilling & Completions recommends following an industry-accepted standard such as OSHA, ASME B30.9-2006, or manufacturer's guidelines when performing any rigging and overhead lifting. Use by untrained persons is hazardous. Improper use will result in serious injury or death. Do not exceed rated capacity.

Working Load Limit (WLL) is the maximum allowable load in pounds which may be applied to the load-bearing device, when the device is new or in "as new" condition, and when the load is uniformly and directly applied. The WLL must never be exceeded.

The Working Load Limit or Design factor may be affected by wear, misuse, overloading, corrosion, deformation, intentional alterations, sharp corner cutting action and other use conditions.

See OSHA Regulation for Slings 1910.184, ANSI/ASME B30.9-"SLINGS", ANSI/ASME B30.10-"HOOKS" and ANSI/AMSE B30.26 "RIGGING HARDWARE" for additional information.

2.D.3 Lift Cylinder Safety (continued):

The flexible line providing hydraulic power to the lift cylinder has been equipped with abrasion-resistant, high visibility protective wrap. The high visibility wrap allows operators to easily see monitor the position of the hydraulic line at all times, and can easily see if the line appears to become entangled or snagged.

IMMEDIATELY CEASE LIFT CYLINDER OPERATION IN THE EVENT OF ENTANGLEMENT OF THE HYDRAULIC LINE WITH FIXED RIG COMPONENTS OR TONG SUPERSTRUCTURE.

The protective wrap also prevents wear of the hydraulic line though abrasion. Do not remove the protective wrap from the lift cylinder line, and replace protective wrap if it is missing, torn, or split. Regardless of use or condition, the hydraulic line supplying the lift cylinder must be replaced every two years.

REPLACE LIFT CYLINDER HYDRAULIC LINE EVERY TWO YEARS

The control valve section on the power tong is equipped with an internal check valve, preventing sudden drop of the tong in the event of hydraulic power failure. A speed-limiting orifice is installed in the breather port of the lift cylinder. The orifice prevents sudden drop of the lift cylinder in the event of a ruptured hydraulic line, limiting the speed at which the cylinder extends and the tong drops to a safe rate. Do not remove the speed-limiting orifice, and only replace with an identical orifice supplied by McCoy.

DO NOT REMOVE THE SPEED-LIMITING ORIFICE FROM THE LIFT CYLINDER BREATHER PORT

The working load limit (WLL) is clearly stenciled on to the side of the lift cylinder. Do not use lift cylinder if the WLL stencil has been rubbed off or intentionally removed. Locate the test certificate that accompanied the cylinder to the job site or, if necessary, obtain a copy of the test certificate from the location at which the original certificate has been stored. The lift cylinder must be clearly re-marked with the WLL before it is released to an operating environment.

DO NOT USE A LIFT CYLINDER WITH A MISSING OR DEFACED WLL STENCIL.

2.E HYDRAULICS

2.E.1 Hydraulic Schematic & B.O.M.

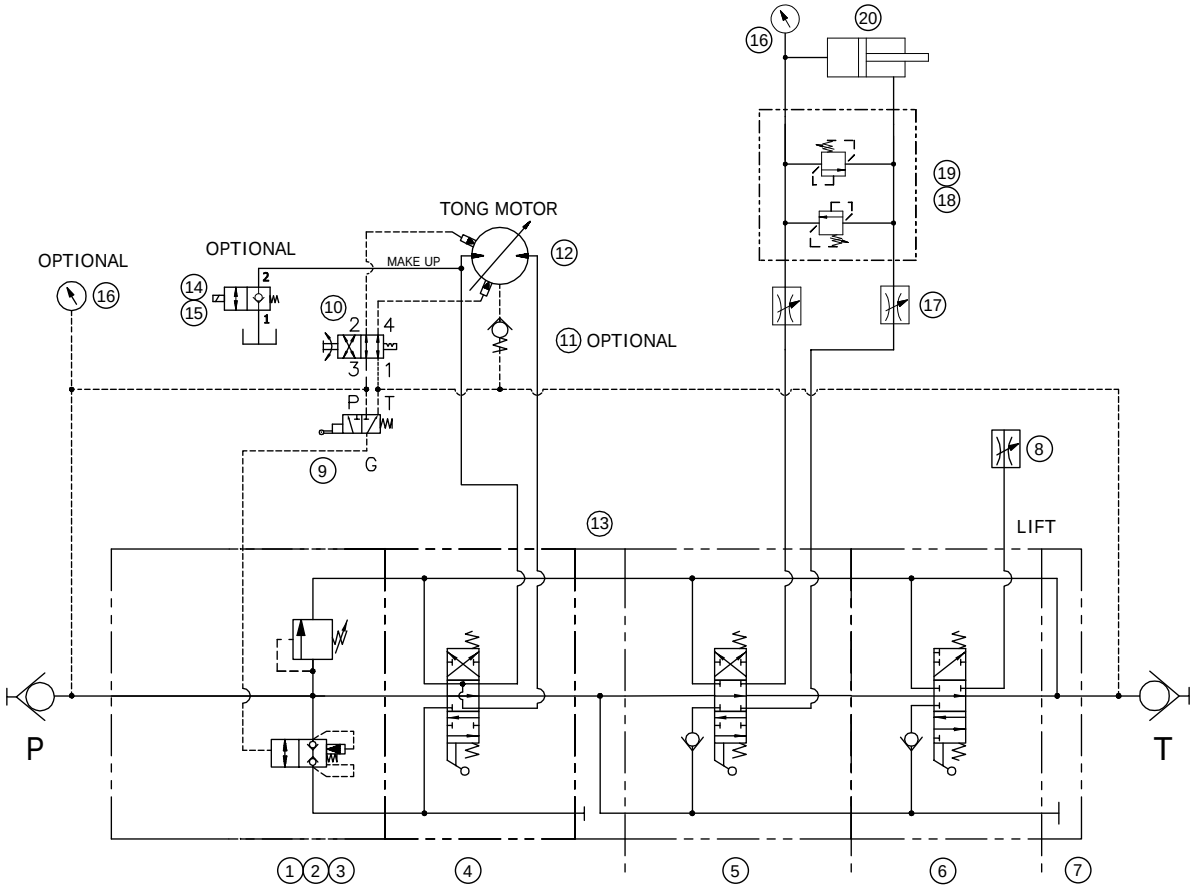


ILLUSTRATION 2.E.1: HYDRAULIC SCHEMATIC

Item	Description	Part Number	Page
1	Inlet Valve c/w safety door cartridge	101-3931	2.13
2	Relief Cartidge - part number varies with application	10-0010R	2.13
3	Pilot-To-Open Valve	08-1625	2.13
4	Motor Section (SAE PORTS)	10-9014	2.13
5	Backup Section (1" ORB PORT)	10-9019	2.13
6	Lift Cylinder Section (1" ORB PORT)	10-9015	2.13
7	Outlet Section (SAE PORT)	10-0086	2.13
8	Flow Control Valve	08-9062	2.13
9	Safety Door Switch	02-E0190	2.14
10	Motor Speed Shift Valve	10-9024A	2.14
11	Check Valve (Optional)	08-9022	Not shown
12	Two-Speed Hydraulic Motor	87-0008	2.14
13	DVA35 Transition Plate	101-3935	2.13
14	Dump Valve	08-9284	2.14
15	Dump Valve Body	08-9283	2.14
16	0-3000 psig Pressure Gauge (not shown)	02-0245	Not shown
17	Flow Control Valve	08-0089	2.15
18	Relief Valve Block	08-0096	2.15
19	Relief Valve	08-1053	2.15
20	Backup Clamp Cylinder	1200131	2.15

2.E.2 Hydraulic Component Identification

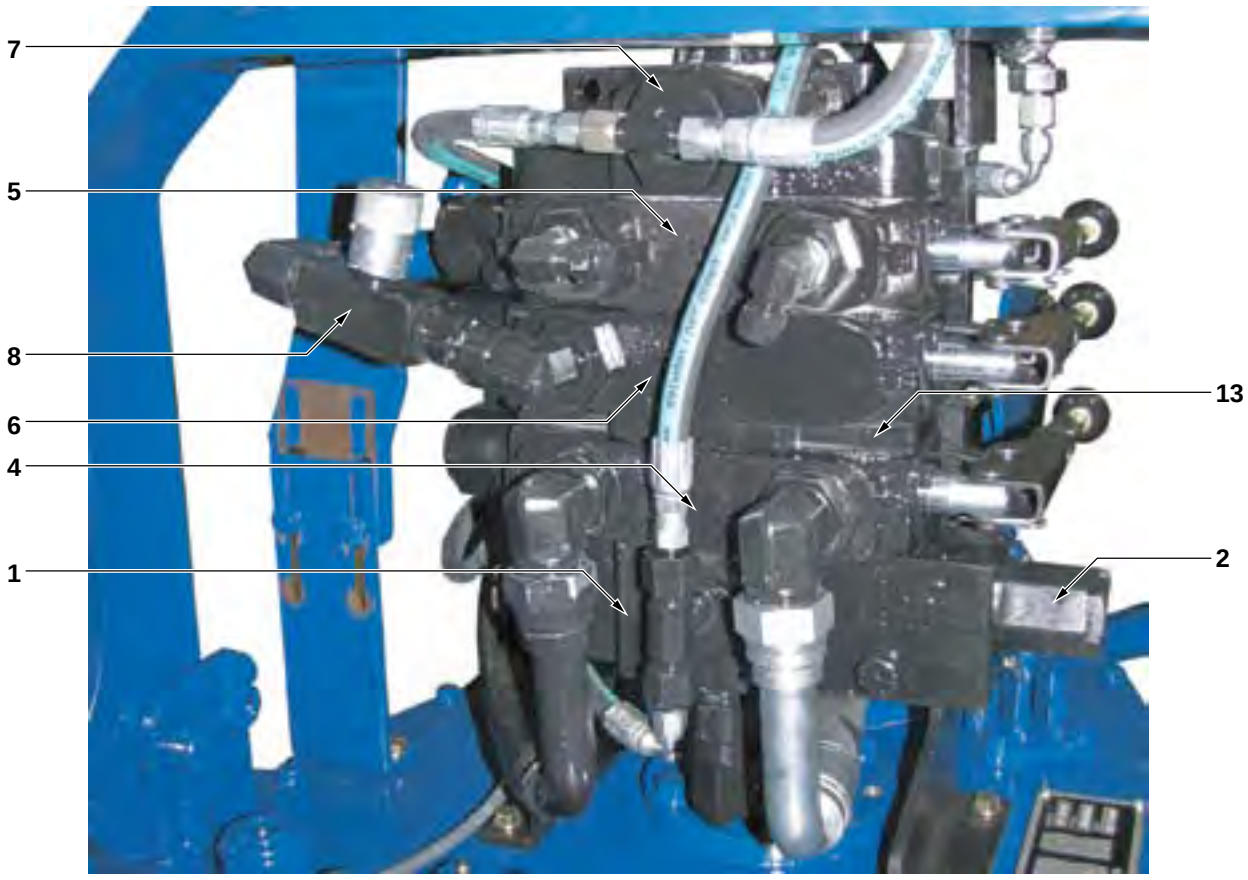


ILLUSTRATION 2.E.2: HYDRAULIC COMPONENT IDENTIFICATION 01

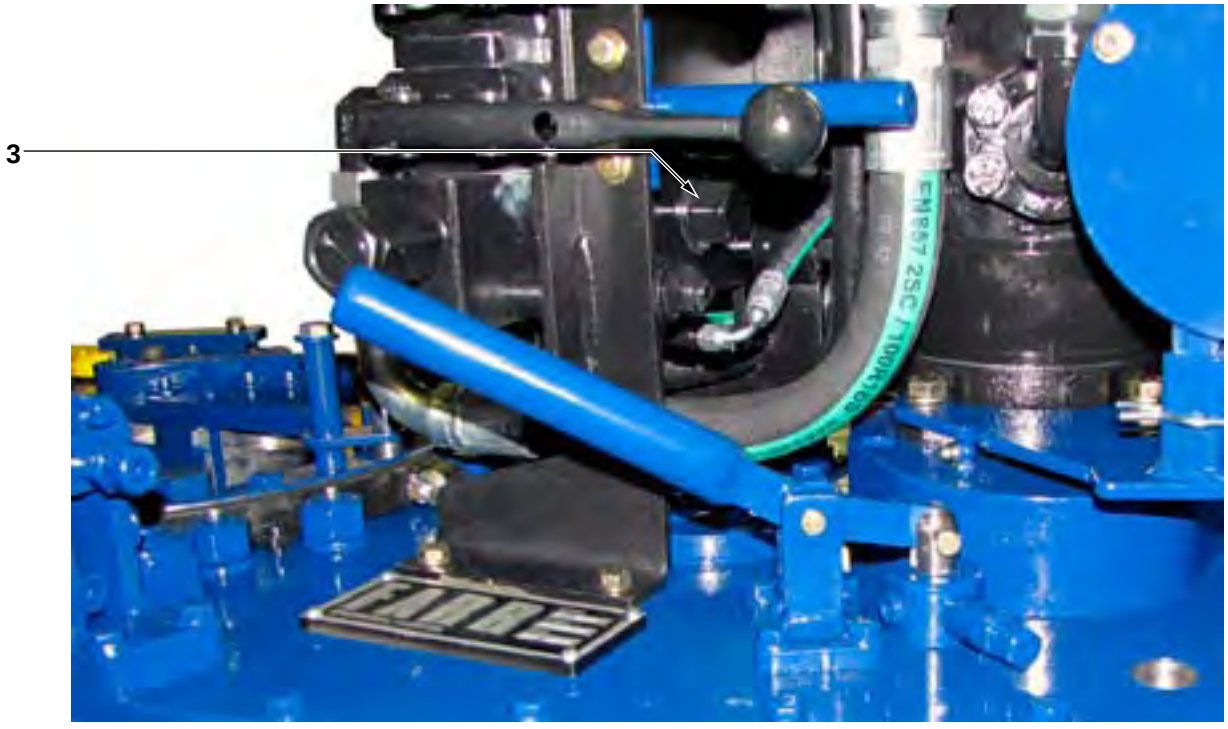


ILLUSTRATION 2.E.3: HYDRAULIC COMPONENT IDENTIFICATION 02

2.E.2 Hydraulic Component Identification (Continued):

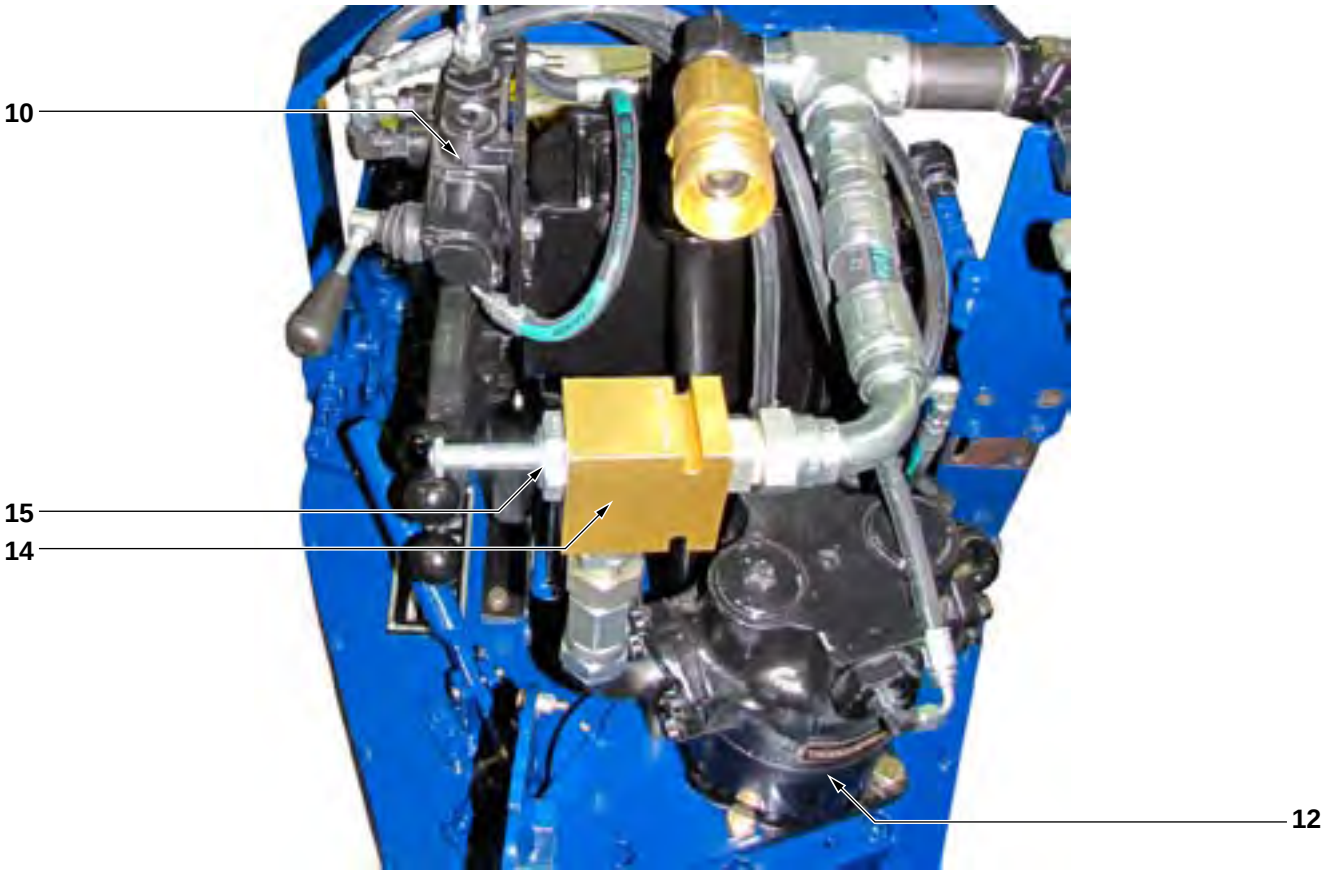


ILLUSTRATION 2.E.4: HYDRAULIC COMPONENT IDENTIFICATION 03

ILLUSTRATION 2.E.5: HYDRAULIC COMPONENT IDENTIFICATION 04

2.E.2 Hydraulic Component Identification (Continued):

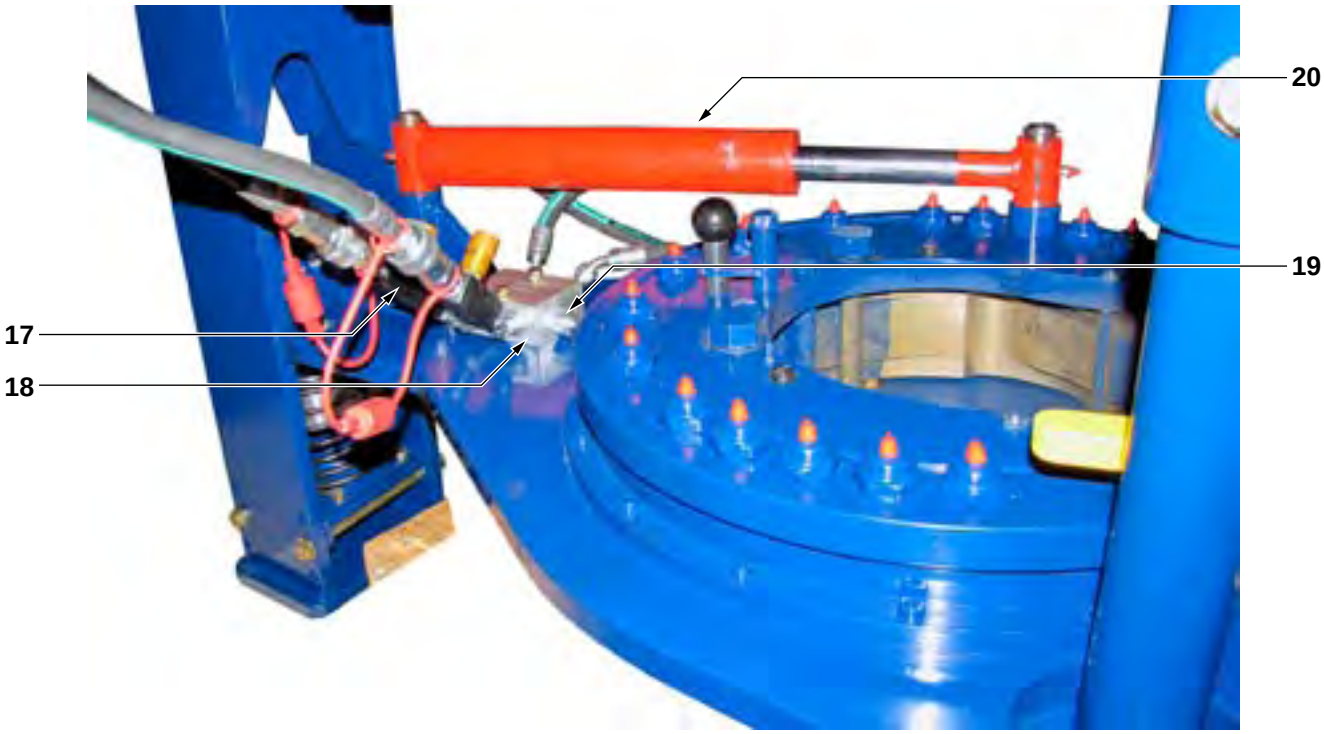


ILLUSTRATION 2.E.6: HYDRAULIC COMPONENT IDENTIFICATION 05

2.E.3 Main Hydraulic Connections

A pair of hydraulic lines - a 1" supply line and a 1-1/4" return line - connect the tong to the power unit (see illustration below). Ancillary devices (hydraulic motors, hydraulic cylinders, etc.) are connected through the valve block.

Perform any hydraulic connection when the power unit is not running, or when the hydraulic pump is disengaged. The possibility of error in inter-changing the high pressure supply hose and the low pressure return hose has been eliminated, because the supply side coupling is smaller than the return side.

ILLUSTRATION 2.E.7: HYDRAULIC CONNECTIONS 01

2.E.3 Main Hydraulic Connections (Continued):

These hose couplings are self-sealing, and care should be taken to ensure complete engagement to prevent partial closure of the check valve in the coupling. Ensure that the nut (female) side is completely made up onto the male connector - there is a line on the male fitting that indicates complete make-up. Snug the female fitting right up to the line.

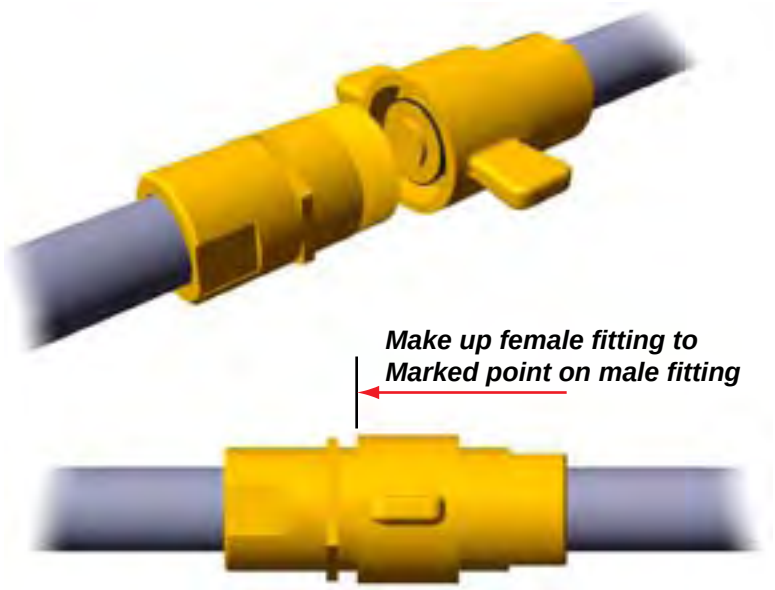


ILLUSTRATION 2.E.8: HYDRAULIC CONNECTIONS 02

2.E.4 Hydraulic Circuit Description

The main hydraulic power source supplies hydraulic fluid to the hydraulic valve block inlet section (Item 1 on the hydraulic schematic and on page 2.7) through a 1" threaded positive-shutoff connection. Hydraulic fluid circulates through the inlet section, the motor control section (Item 3 on the hydraulic schematic and on page 2.7) and the outlet section (Item 4 on the hydraulic schematic and on page 2.7) at maximum tong pressure before returning to the hydraulic fluid reservoir (the "tank") through a 1-1/4" threaded positive-shutoff connection. The relief valve (Item 2 on the hydraulic schematic and on page 2.7) is factory adjusted to limit the maximum operating pressure of the tong to that which will allow maximum torque. Maximum operating pressure and maximum torque are listed in the specifications on page 1.3.

Actuating the valve handle on the motor control section directs hydraulic fluid to the hydraulic motor (Item 9 on the hydraulic schematic and on page 2.7), through the safety door relief valve block (Items 5 & 6 on the hydraulic schematic and on page 2.7), causing rotation of the motor. During normal operation pilot pressure from the safety door switch (Item 7 on the hydraulic schematic and on page 2.8) directs pilot pressure to actuate the safety door check valves, allowing full hydraulic power to the motor. The configuration of the plumbing between the motor valve section and the motor determines the direction of rotation for a given valve action. McCoy Drilling & Completions | FARR normally configures the plumbing on this tong so that pushing the valve control handle towards the centre of the tong supplies hydraulic pressure to the "clockwise rotation" side of the motor, which is the desired direction of rotation for making up a tubular connection. Conversely, pulling the valve control handle towards the operator supplies hydraulic pressure to the "counter-clockwise rotation" side of the motor, which is the desired direction of rotation for breaking out a tubular connection. Releasing the valve handle enables the valve to go to a neutral position, directing all hydraulic fluid to the outlet section and "back to tank". A check valve (Item 8 on the hydraulic schematic and on page 2.7) installed on the case drain line between the motor and the main tank return line, or the internal case drain, protects the motor from excess pressure in the event of blockage in the tank line.

Actuating the valve handle on the lift cylinder section directs hydraulic fluid to the lift cylinder, which is connected to the master link on the rigid sling and provides raising and lowering functions to the tong and backup assembly. Although the lift cylinder is designed to be a double-acting cylinder, normally only the "lift" side is connected to hydraulic pressure from the lift cylinder valve. Actuating the lift cylinder valve in the "lower" direction provides a path to tank for the hydraulic fluid in the lift cylinder and allows the load suspended on the lift cylinder to force the hydraulic fluid from the cylinder, through the valve. In other words the "lowering" action is a function of gravity, not active hydraulics. The position of the lift cylinder valve controls the rate at which the cylinder lowers the tong and backup assembly. An adjustable needle valve on the pressure line to the lift cylinder allows an operator to set the rate at which hydraulic fluid is supplied to the lift cylinder, thus controlling the rate at which the cylinder raises and lowers. A breather port installed in the opposite side of the lift cylinder allows the cylinder to breathe as the piston in the lift cylinder moves. The configuration of the plumbing between the lift cylinder valve section and the cylinder determines the action of the lift cylinder for a given valve action. McCoy Drilling & Completions | FARR normally configures the plumbing on this tong so that pulling the valve control handle towards the operator supplies hydraulic pressure to the lift cylinder, which causes the cylinder to retract, thus providing a lifting action. Conversely pushing the valve control handle towards the centre of the tong allows a path back to tank, which allows gravity to extend the cylinder and lowers the equipment. Allowing the handle to go to neutral stops all hydraulic fluid movement to or from the lift cylinder.

2.E.4 Hydraulic Circuit Description (Continued):

Actuating the valve handle on the backup control section directs hydraulic fluid to the double-acting backup clamping cylinder. This is not proportional control, meaning that actuating the control valve enables a fixed hydraulic output to the cylinder. The configuration of the plumbing between the backup valve section and the backup cylinder determines the clamping action of the backup cylinder for a given valve action. McCoy Drilling & Completions | FARR normally configures the plumbing on this tong so that pushing the valve control handle towards the centre of the tong clamps the backup for make-up operations, and pulling the valve control handle toward the operator clamps the backup for break-out operations. Adjustable needle valves on each backup cylinder line allows the operator to set the rate at which hydraulic fluid is supplied to the backup cylinder, thus controlling the rate at which the cylinder clamps and un-clamps. Adjustable relief valves on each backup cylinder line allows the operator to set the clamping pressure for both make-up and break-out operations.

Hydraulic fluid at maximum tong pressure flows from the valve inlet section to the safety door switch. During normal operation the plunger on the safety door switch is depressed when the tong door is closed, directing a hydraulic pilot signal to both safety door relief valves (Item 5 on the hydraulic schematic and on page 2.7). This pilot pressure actuates the safety door check valves, allowing full system pressure to the motor when the motor control valve is manipulated. Releasing the plunger on the safety door switch by opening the tong door diverts all hydraulic fluid from the safety door switch to the tank line, interrupting pilot pressure to the safety door check valves. The relief valves close, immediately inhibiting system pressure to the motor. Full hydraulic power to the motor cannot be restored until the plunger on the safety door switch is depressed by fully closing the tong door.

2.F TONG / BACKUP JAW AVAILABILITY & INSTALLATION

2.F.1 Jaw Availability

The following table lists all jaw die kits that are available as standard stocked sizes for this model of tong. McCoy Drilling & Completions | Farr offers a good selection of standard jaw sizes. However, please note that we can custom-engineer and manufacture any size of jaw within the range of the tong. Jaw systems are available to allow use of die inserts intended for specialized applications. Call our sales office for information on jaw and die systems designed for higher or lower grip, or non-marking applications.

The table lists standard contoured, flat and wraparound die inserts that are available as spare parts. However, a wide variety of diamond-tooth, GRITFACE®, aluminium, and wrap-around fine-tooth dies are available for specialized applications. Please refer to our website for complete information:

http://www.mccoyglobal.com/dies-inserts

Description	Part Number	Description	Part Number
2-7/8" Jaw Die Kit [1]	AK21-JDK-2875	5-3/4" Jaw Die Kit	AK21-JDK-5750
3-1/2" Jaw Die Kit [2]	AK21-JDK-3500	6-5/8" Jaw Die Kit	AK21-JDK-6625
4" Jaw Die Kit	AK21-JDK-4000	7" Jaw Die Kit	AK21-JDK-7000
4-1/2" Jaw Die Kit	AK21-JDK-4500	7-5/8" Jaw Die Kit	AK21-JDK-7625
5" Jaw Die Kit	AK21-JDK-5000	8-5/8" Jaw Die Kit	AK21-JDK-8625
5-1/2" Jaw Die Kit	AK21-JDK-5500	9-5/8" Jaw Die Kit	AK21-JDK-9625
[1] Uses jaw die 12-0007	[2] Uses jaw die 12-0011	All remaining jaw die kits use flat die PN 12-1004	

JAWS MAY PRODUCE METAL SLIVERS. WEAR STURDY GLOVES WHEN REMOVING AND INSTALLING JAW DIE KITS.

2.F.2 Jaw Removal

The tong jaws will often require removal to change jaw size or replace worn jaw die inserts. Open the tong door to disable tong rotation (rotation is inhibited by safety door systems). Support the jaw being removed from the bottom, and use a wrench to loosen and remove the jaw pivot bolt. Slide the jaw away from the rotary gear towards the centre of the cage plate assembly, and lift clear of the tong (see Illustration 2.F.1). Repeat for the other jaw.

DO NOT ACCESS ROTATING COMPONENTS UNLESS HYDRAULIC POWER SUPPLY HAS BEEN DEACTIVATED OR ISOLATED.

2.F.2 Jaw Removal (Continued):

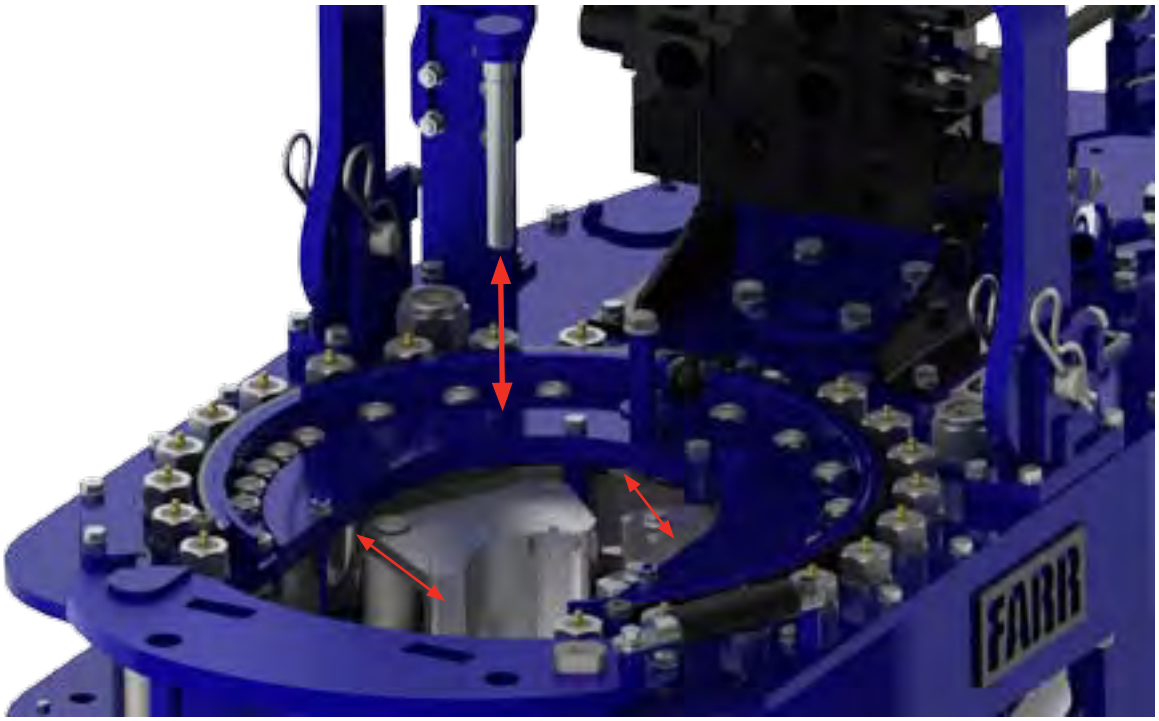


ILLUSTRATION 2.F.1: JAW REPLACEMENT

Once the jaw has been removed the jaw dies may be replaced by removing the keeper screw above the die, and tap the die from jaw using a hammer. Replace the die, tapping it into place if necessary, and replace the keeper screws.

Jaws used for the backup are identical to those used in the tong, and backup jaws are removed in exactly the same fashion as the tong jaws

2.G TONG RIG-UP & LEVELING

2.G.1 Suspension & Restraint

Suspend the tong from a location as near to the centre of the drill rotary as possible, and from a location high enough on the mast to ensure easy handling. The lower the point from which the tong is suspended, the more effort will be required to move the tong to and from the connection point.

The suspension line may be extended over a pulley and balanced by a counterweight equal to the weight of the tong, or simply tied off in the derrick to form a dead line. When using a dead line arrangement it is necessary to use a FARR spring hanger assembly (see specification page for recommended spring hanger). This spring hanger compensates for the downward movement of the casing as the thread is made-up, and imparts additional force to the suspension cable:

- a "single spring" hanger typically applies 420 lbs. (191 kg.) to the suspension line for every inch of thread made up
- a "double spring" hanger typically applies 840 lbs. (382 kg.) to the suspension line for every inch of thread made up

If you do not know which specific spring hanger is in use, check the specification page in this manual for information on the recommended spring hanger for this application. McCoy Drilling & Completions will not guarantee or specify spring hangers other than what has been supplied by McCoy.

Many applications use a lift cylinder for adjusting the height of the tong. Ensure the weight of the lift cylinder is known if it has not been included in the total weight of the tong.

All forces upon the suspension line must be considered when calculating necessary strength of the suspension line. The weight of the tong, the weight of the lift cylinder, the weight of the spring hanger, and the force imparted on the suspension line by the spring hanger must all be added together in order to arrive at the total force supported by the suspension line. Select your suspension line based upon the total force and the margins of safety dictated by the policies of your company and by established engineering practices. Ultimately, calculating the force on the suspension line and selection of the suspension line is the complete responsibility of the customer.

2.G.1 Suspension & Restraint (Continued):

McCoy Drilling & Completions recommends using dual backup (snub) lines of sufficient strength to withstand the force imparted by the maximum rated torque of the tong and backup assembly in use. The snub lines will arrest uncontrolled movement of the tong and backup in the event slipping of the backup jaws. Calculate the force on the snub lines by dividing the maximum torque of the tong by the tong's torque arm (expressed in feet). For example, an 22,000 lbs.-ft. tong with a 28 inch (2.333 ft.) torque arm will generate 9430 lbs. of force against the snub line. Select your snub lines based upon the total force and the margins of safety dictated by the policies of your company and by established engineering practices. Ultimately, calculating the force on the snub line and selection of the snub line is the complete responsibility of the customer.

Snub lines must be securely connected to the rear of the tong and backup assembly, and tied off to a suitably rated anchor. When properly installed the snub line should be taut enough to allow very little movement, preventing the tong from generating excessive force on the lines by "snapping" tight when rotation is applied.

MCCOY DRILLING & COMPLETIONS ACCEPTS NO RESPONSIBILITY FOR DESIGNING AND SELECTING AN ADEQUATE SUSPENSION AND RESTRAINT SYSTEM FOR YOUR DRILLING EQUIPMENT. FAILURE TO FOLLOW THE INSTRUCTIONS PROVIDED IN THIS SECTION MAY RESULT IN SERIOUS INJURY TO THE OPERATOR.

ALL SELECTED FASTENERS, SHACKLES, CLAMPS, ETC. USED FOR CONSTRUCTING THE SUSPENSION AND SNUB LINES MUST BE RATED FOR THE CALCULATED FORCES.

2.G.2 Tong Leveling

The tong must be leveled side-to-side and front-to-rear before placing into service. The following guidelines will assist you when leveling your tong.

i. Place a level axially (side to side) across the tong, ensuring that it is parallel with the surface of the tong. Use a thin wrench on the flat of the adjusting helix to rotate the helix, forcing the lift link to move towards the outer supports of the sling. The 3/4" nylock nut on the pin may have to be slightly loosened to allow the helix to rotate. Adjust the helix until the level shows that the tong is level side-to-side.

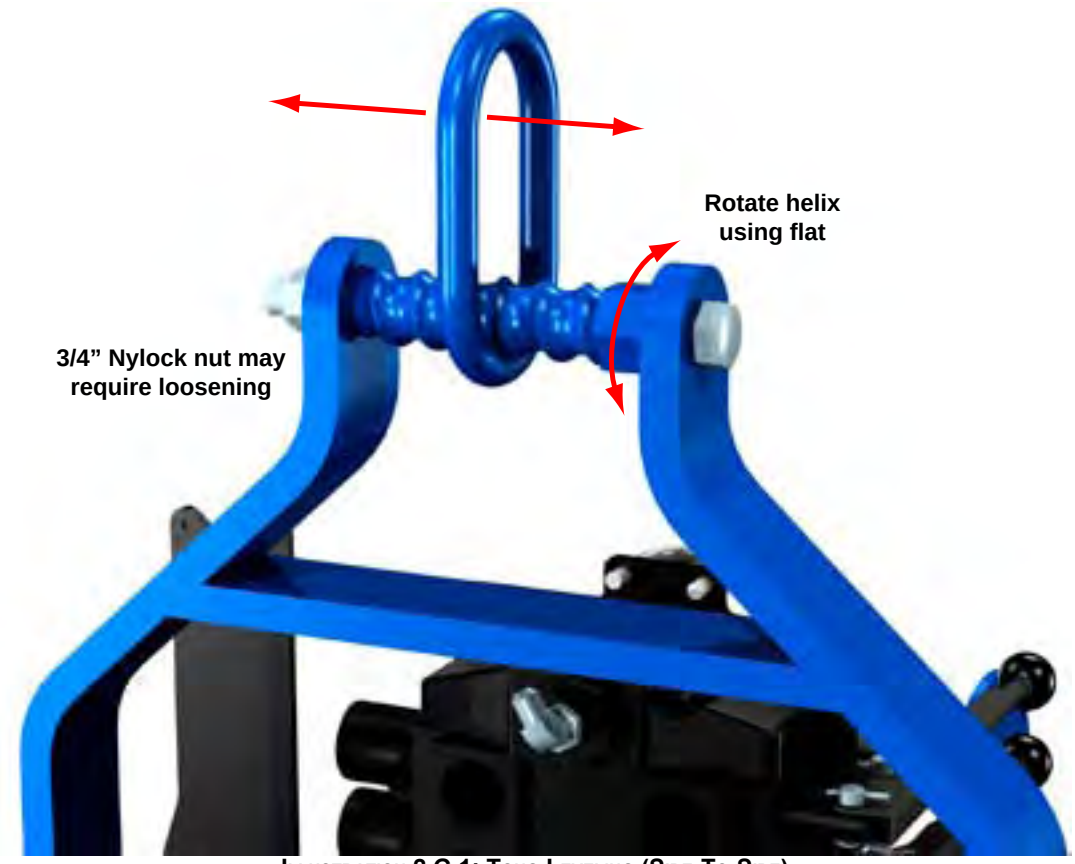


ILLUSTRATION 2.G.1: TONG LEVELING (SIDE-TO-SIDE)

2.G.2 Tong Leveling (Continued):

ii. Place a level lengthwise (front to back) along the tong, ensuring that it is parallel with the surface of the tong. Loosen the 1/2" jam nuts on the adjusting bolts on rigid sling brackets. Completely loosen the adjusting bolts. Turn each adjusting bolt equally until tong hangs level front-to-back. Lock adjusting bolts in place with the jam nuts.

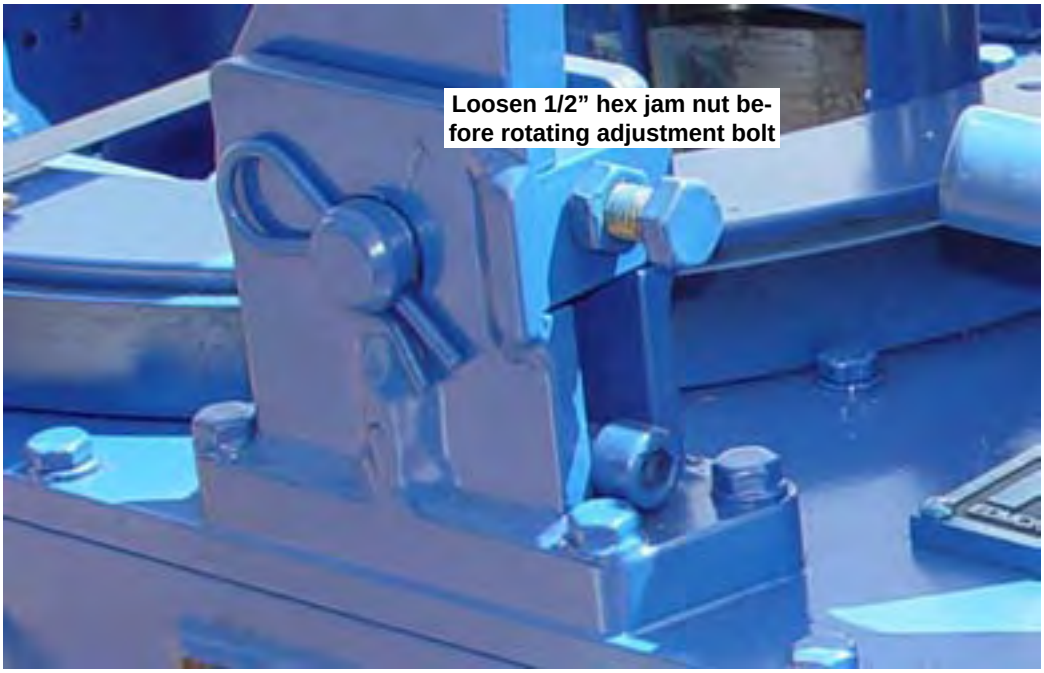


ILLUSTRATION 2.G.2: TONG LEVELING (FRONT-TO-REAR)

2.G.3 Load Cell Configuration

The backup is directly coupled to the compression load cell via the backup body paddle. The load cell hanger is simply hung on the paddle and secured through the top of the "U" by a bolt and washer set, and in normal operation does not need to be adjusted or removed. The assembly in the first of the following two illustrations has been configured in the "make-up" configuration; to convert the assembly to the "break-out" configuration remove the bolt and washer set securing the load cell holder to the paddle, and move the entire assembly to the other side of the paddle.

ILLUSTRATION 2.G.3: LOAD CELL CONFIGURATION - MAKE UP

2.G.3 Load Cell Configuration (Continued):

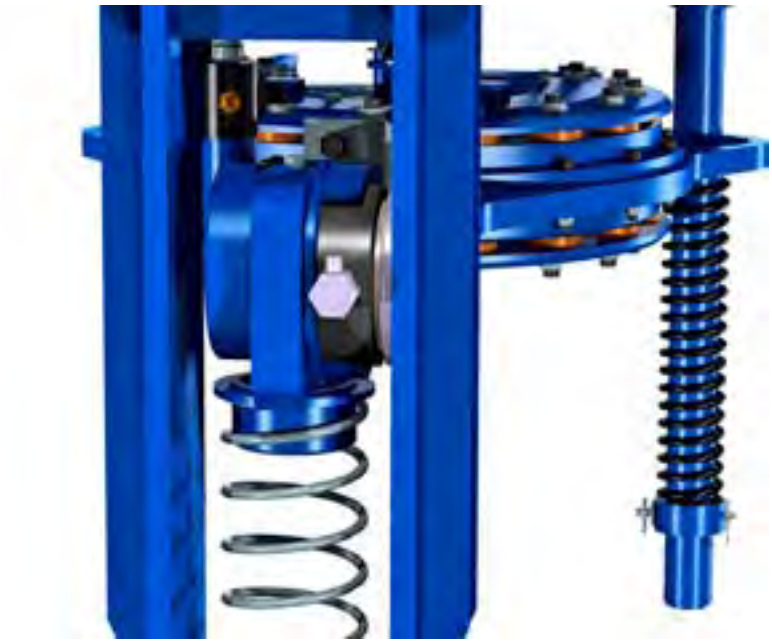
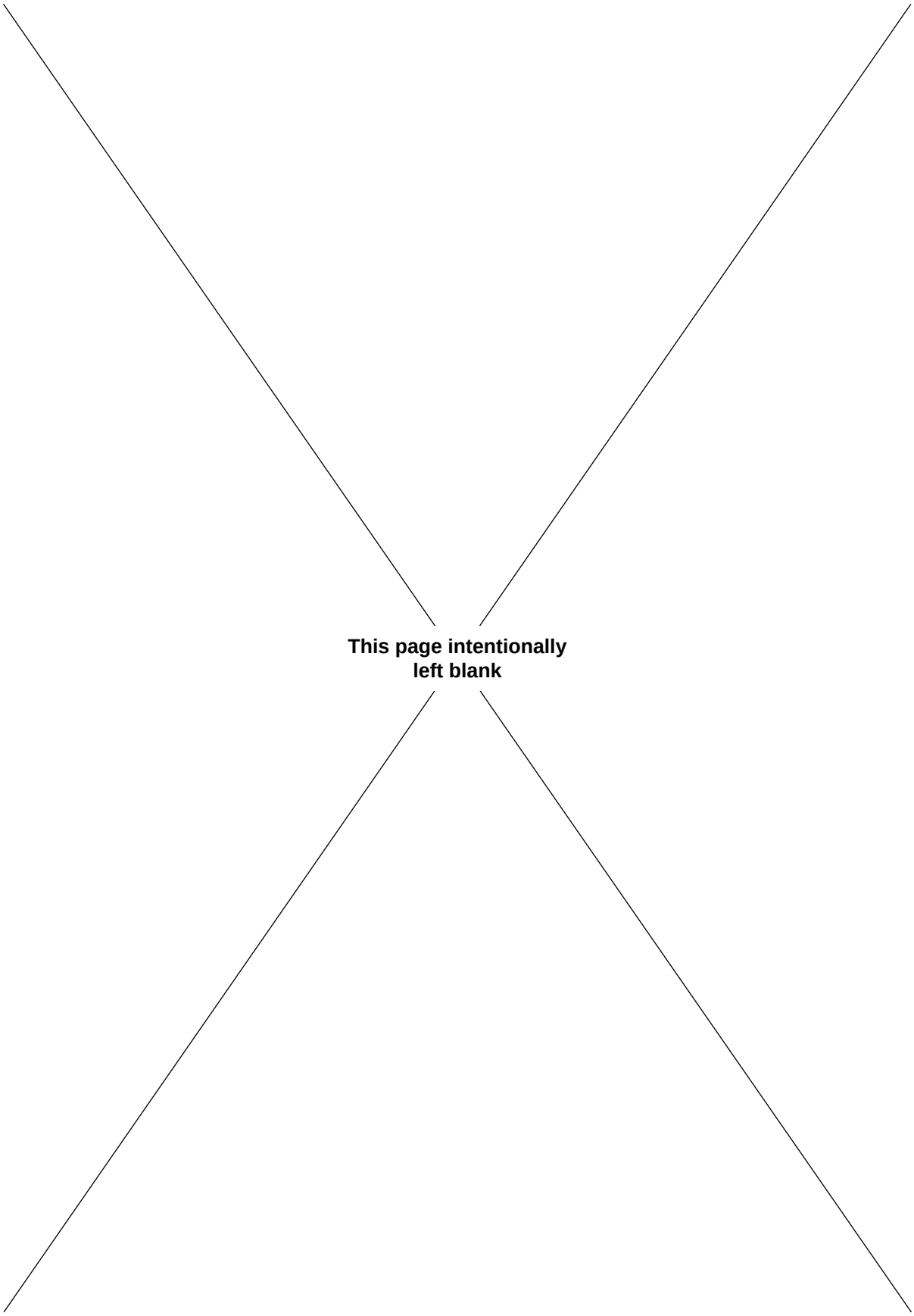


ILLUSTRATION 2.G.4: LOAD CELL CONFIGURATION - BREAK OUT



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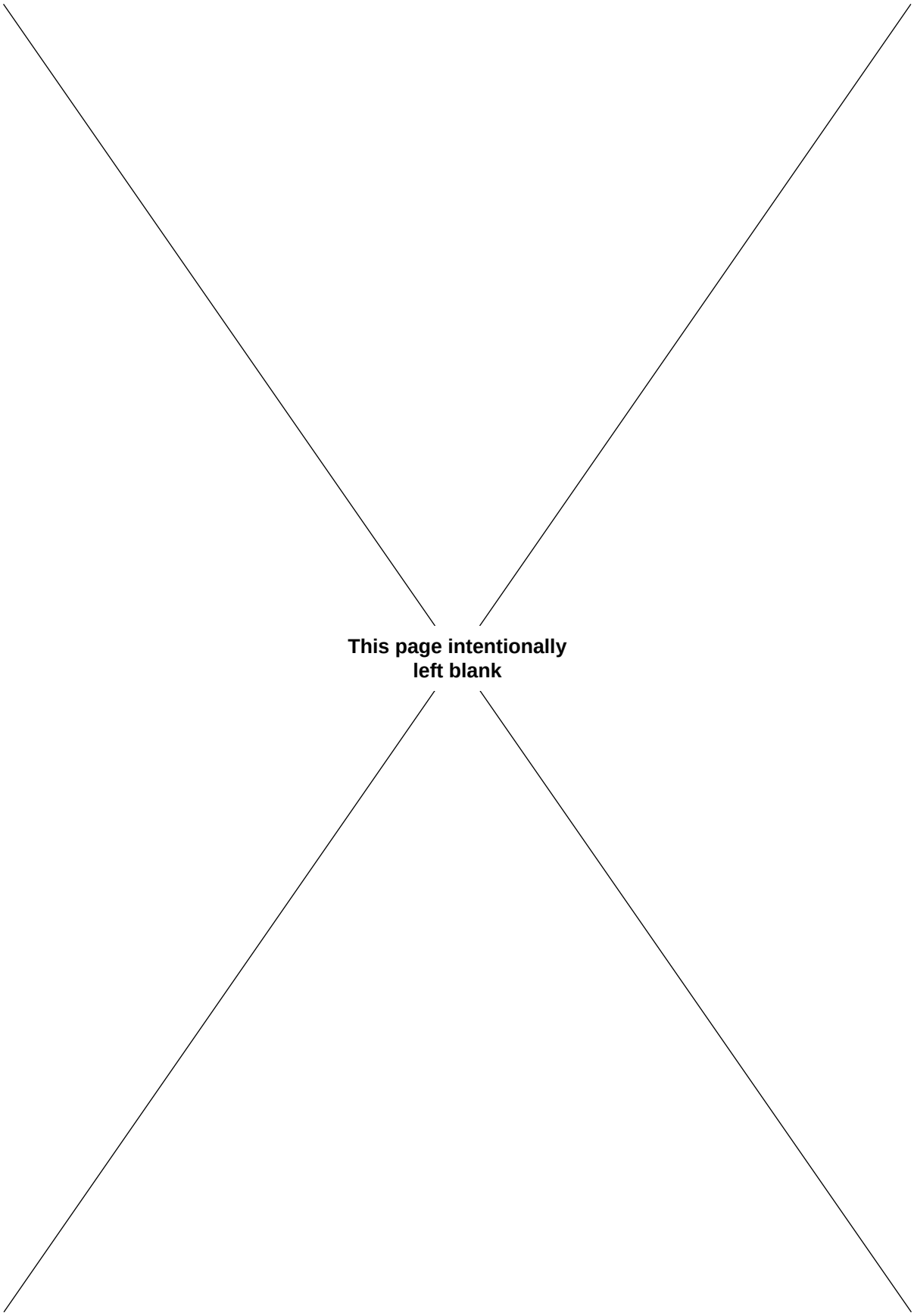
MOVING GLOBAL ENERGY FORWARD

SECTION 3: OPERATION



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3.A TONG OPERATION

3.A.1 Operator Training

Many companies set qualification standards that must be met before equipment may be operated without supervision. McCoy Drilling & Completions recommends operator training, which typically consists of operation of the equipment under the supervision of a trained equipment operator until a satisfactory level of competence is achieved. Typical operator training should include:

- Introduction to and general description of equipment
- Technical specifications and performance data
- Operating instructions
- Control systems and interlocks
- Operating hazards
- Checks and inspections

3.A.2 Operator Safety

McCoy recommends that a hazard assessment of the work area be performed by a designated safety representative before commencing operations. A designated safety representative is responsible for verifying that all operators have adequate equipment and safety training.

The safety door system is the primary device protecting the tong operator and nearby personnel from the rotary gear. Confirm the correct operation of the safety door before every job. Never disable the safety door device.

The area surrounding the tong operating area must be clutter-free and free from tripping hazards, or protruding objects that may snag hydraulic hoses on the tong, backup, lift cylinder, or torque measurement system. Operating surface or drill floor must be kept free of slipping hazards like grease, oil, water, etc.

Adequate lighting of the work area is required. All warnings, labels, gauges, and signs must be clearly visible

The components of the tong commonly manipulated or requiring control input are painted green, and are safe for continuous handling. Areas painted yellow are designated as hazardous areas, and contact with those areas must be avoided during operation. Always wear all personal protective equipment (PPE) specified by your company's HSE policy, and follow all of your company's safety guidelines.

ALWAYS WEAR APPROVED PERSONAL PROTECTIVE EQUIPMENT (PPE) WHEN OPERATING HYDRAULICALLY-POWERED EQUIPMENT.

Ensure hydraulic power is deactivated and tong hydraulics are de-pressurized before disconnecting the main hydraulic lines. McCoy recommends depressurizing the tong hydraulic system before connecting or disconnecting quick-connect fittings.

DEPRESSURIZE EQUIPMENT BEFORE DISCONNECTING MAIN HYDRAULIC LINES.

3.A.3 Valve Operation

4-way proportional valves control operation of hydraulic devices on the tong assembly such as hydraulic motors and cylinders. When any one valve is "centered" or in the detent position, there is no hydraulic output from the valve. When the valve is pushed forward there is an effect, and when the valve is pulled back, there is an opposite effect. These valves feature proportional control, which means that further extension of the valve handle (thereby further opening the valve orifice) results in proportionally higher hydraulic output to the controlled device.

The illustrations on the following pages demonstrate the type and effect of the hydraulic valves with which this tong is may be equipped.

3.A.3 Valve Operation (Continued):

TONG MOTOR

This is a proportional valve. Pushing the valve handle forward will cause the tong motor to rotate in a clockwise direction (as seen from the top of the tong). This is the desired direction of rotation for making up a joint. Pulling the valve handle in the opposite direction results in counter-clockwise rotation, which is the desired direction of rotation for breaking out a joint.

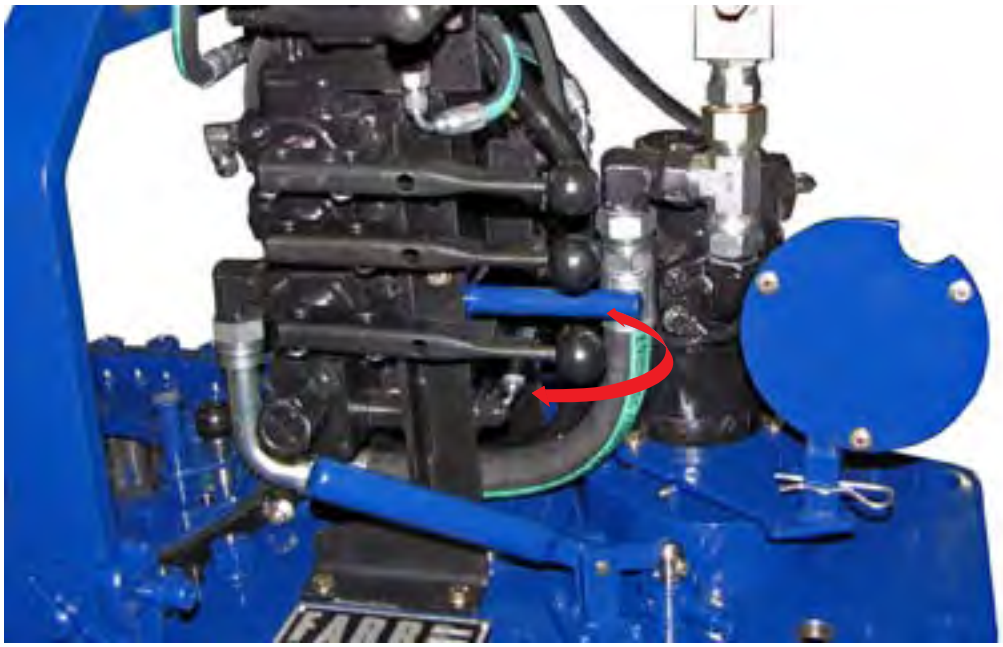

ILLUSTRATION 3.A.1: TONG ROTATION CONTROL VALVE

LIFT CYLINDER CONTROL VALVE

This is a direct-acting valve. Pushing the valve handle forward will cause the lift cylinder to lift the tong vertically. Pulling the valve handle in the opposite direction will cause the lift cylinder to lower the tong. Releasing the valve handle will immediately stop the lifting or lowering action.

The needle valve on the discharge of the lift cylinder control valve regulates hydraulic fluid flow to the lift cylinder. Closing the needle valve (rotating the knob clockwise) will increasingly restrict the flow rate of the fluid, resulting in slower actuation of the cylinder in both directions (lifting & lowering).

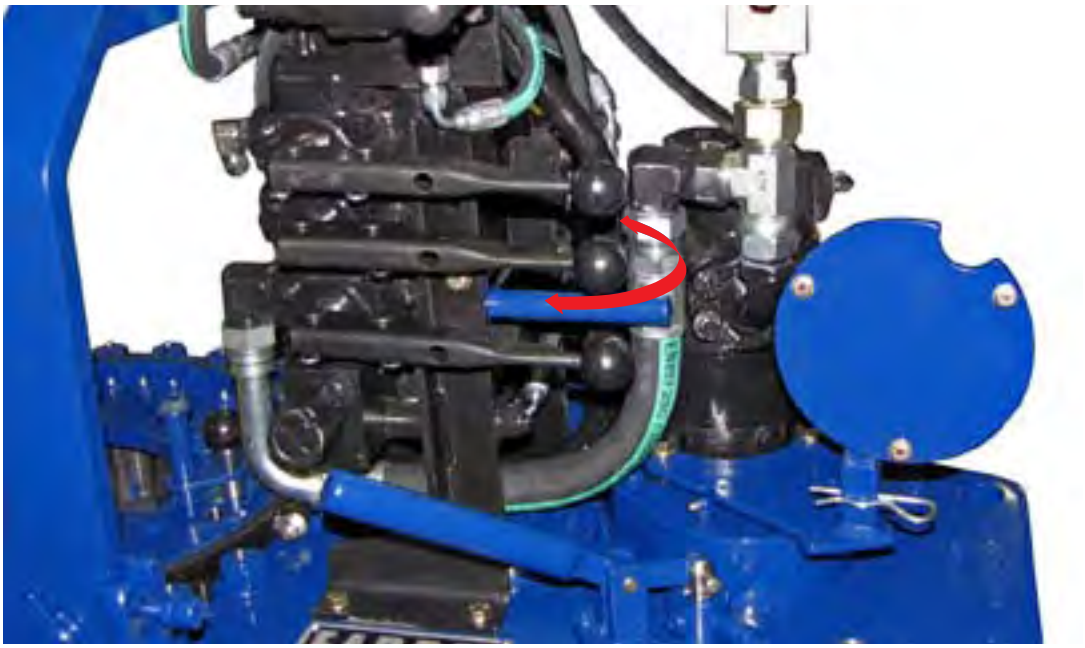

ILLUSTRATION 3.A.2: LIFT CYLINDER CONTROL VALVE

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3.A.3 Valve Operation (Continued):

BACKUP

This is a two-way direct acting valve, without proportional control. Pushing the valve handle forward will cause the backup to engage. Pulling backward, towards the operator, reverses the operation.

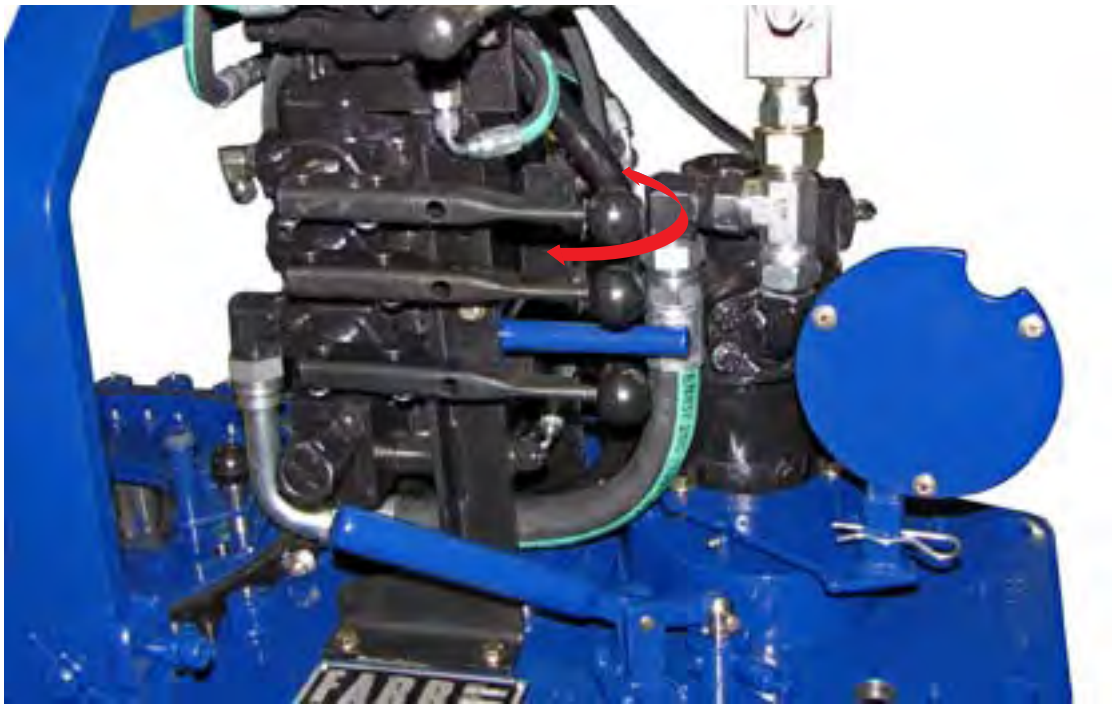

ILLUSTRATION 3.A.3: TONG BACKUP CONTROL VALVE

MOTOR SPEED

This valve sets the speed of the two-speed motor. Pulling the motor speed control all the way out sets the motor speed to LOW. Maximum torque is only available when the motor speed is set to LOW. Pushing the valve handle towards the centre of the tong sets the motor speed to HIGH, which is useful for rapidly un-threading broken connections.

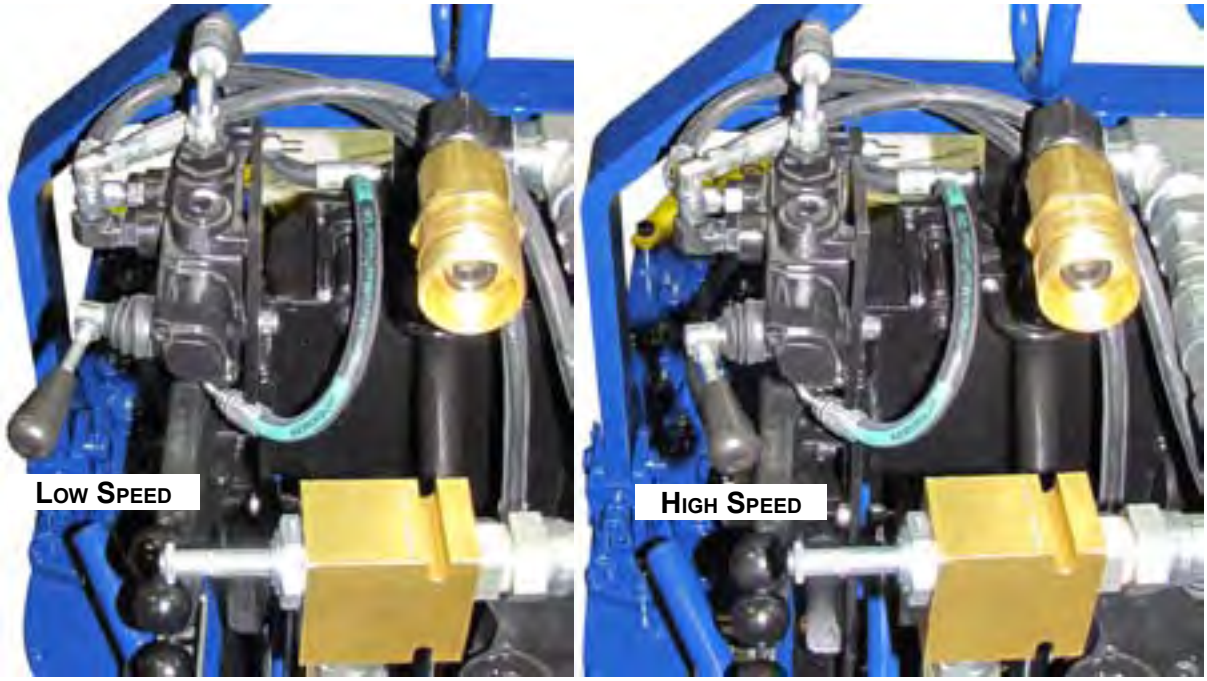

ILLUSTRATION 3.A.4: TONG MOTOR SPEED CONTROL VALVE

3.A.4 Shifting Gears

The shifting shaft has three "detent" positions identifying the low speed/high torque position, the "neutral" or free-spinning position, and the high speed/low torque position. The detent strength may be adjusted by releasing the locknut on the detent tube and increasing or relaxing pressure on the detent spring. Ensure the locknut is tightened once the desired detent pressure has been set.

To shift to the high-speed gear, move the shifting handle upward from neutral position. To shift to the low-speed gear, move the shifting handle down through the neutral detent to its lowest position. Note that the high clutch gear or the low clutch gear may not be exactly aligned when shifting, so the operator may need to "bump" the motor control handle slightly to turn the main clutch gear shaft and shifting collar into alignment. This is most effective when applying a small amount of pressure on the gear shift lever in the direction you want to shift the tong, ensuring the shifting collar will "catch" when the main clutch gear aligns with either the high or low clutch gear (see Illustration 2.G.4).

SHIFTING TONG WHILE ROTATING THE MOTOR AND CAGE PLATE MAY RESULT IN CATASTROPHIC GEAR TRAIN FAILURE

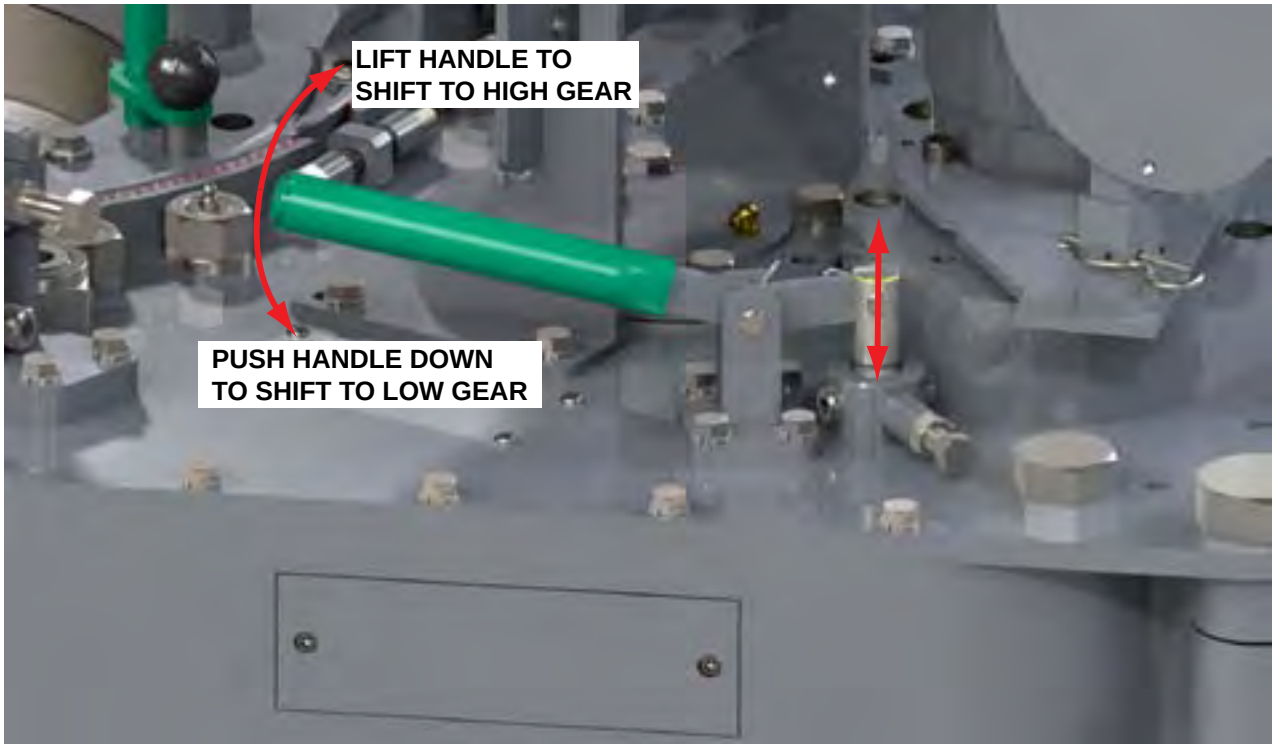

ILLUSTRATION 3.A.5: TONG MANUAL SHIFT CONTROL

3.A.5 Pre-Operational Checks

McCoy recommends that the following pre-operating tests be performed prior to releasing the tong assembly to a operational environment:

1. Connect the tong to a hydraulic power source in a controlled environment. Ensure the power unit's operating parameters are within the specifications as identified on Pg. 1.3. Ensure the hydraulic connections from the power unit are properly and securely made up (see Section 2.D.3). Do not neglect to connect the motor drain line.
2. Start the power unit as specified by the power unit operator's manual. Open the Bypass Valve on the hydraulic system, and inspect all pressure and return line hose connections to ensure correct and secure installation. A restriction in the pressure supply hose will result in high pressure within the power unit hydraulic system, which will activate the hydraulic governor and increase the engine speed to as high as maximum RPM. A restriction in the return line will result in high pressure within the power unit and the tong hydraulic system, causing engine speeds as high as maximum RPM, and possible failure of the motor seal.

A CLEARLY IDENTIFIED REMOTE POWER PACK EMERGENCY STOP MUST BE INSTALLED IN THE IMMEDIATE VICINITY OF THE TONG OPERATOR.

3.A.5 Pre-Operational Checks (continued):

3. Allow hydraulic system to warm by circulating fluid for about 10 minutes, then slowly close the bypass valve to allow hydraulic fluid to circulate through the hoses and tong. Ensure circulating pressure does not exceed 200 psi.
4. Inspect all hydraulic hoses and connections on the tong. Immediately correct any hydraulic fluid leaks.
5. Inspect all gauges. Replace leaking or cracked gauges, or any gauge not registering a reading.
6. Confirm that all load-bearing pins and R-clip retainers are installed and in good condition (rigid sling pins, lift cylinder pins).
7. Confirm all hydraulic hoses (with the exception of the supply & return to the backup) are securely fastened to the tong, and are not in contact with the cage plate or creating a snagging hazard.
8. Ensure the tong door is securely closed before rotating tong.

DOOR MUST BE CLOSED AND SECURELY LATCHED BEFORE TONG ROTATION IN ORDER TO ASSURE THE SAFETY OF OPERATING PERSONNEL.

9. Shift the tong to low gear (see Section 2.I.3) and rotate the tong slowly forward for approximately a minute. Stop the tong and then reverse the rotation direction for approximately another minute. Stop the tong, shift to high gear, and operate in high gear for approximately another minute. Stop the tong and rotate in the opposite direction in high gear for approximately another minute. If at any time abnormal operation is suspected (surging, grinding, squealing, or other noises deemed to be unusual, or failure to operate) discontinue operation of the tong and contact McCoy Drilling & Completions immediately.
10. Re-inspect all hydraulic lines and connections on the tong, and correct all leaks.
11. The safety door system is the prime protective measure separating the operator from the rotary gear, and must be in working condition when operating tong. Carefully inspect the safety door components, and test the operation of the safety door using the following procedure:
    i. Keep non-essential personnel clear of the unit under test. This test procedure will only include two people: one to run the control valve and one to operate the door.
    ii. Ensure the tong door is securely closed.
    iii. Shift to LOW gear.
    iv. Begin rotating the tong (direction of rotation is not important).
    v. Open the tong door while the rotating the tong. The tong must immediately and completely stop rotating as soon as the door is opened.
    vi. Continue to apply rotation control, and open & close the door throughout its complete range. Slowly close the door until it latches. Rotation must not begin until the door is completely closed and securely latched.

If the safety door does not operate as designed, the safety door switch may require adjustment, or further troubleshooting of the safety door system may be required. See Section 3.F.4 for safety door switch adjustment procedures, and Section 4.D for safety door troubleshooting instructions.

The safety door switch is protected from impact by a sturdy metal guard, painted yellow. This guard must be inspected before each use of the tong. All components of the guard must be in place, and all fasteners securing the guard must be intact and tight. Ensure wire ties (where applicable) on safety door components are present and secure, and do not show signs of tampering.

DO NOT OPERATE TONG WITH A MALFUNCTIONING OR NON-OPERATING SAFETY DOOR SYSTEM.

3.A.6 General Comments

Position rotary gear in contact with both idler gears when making up or breaking out joints or collars when torque in excess of 50% of the rated torque is required.

When making-up integral (shouldered) joints, it is essential to make up the last turn of the threads in low gear. This reduces the tendency of an instant stop or a sudden increase in torque, which induces extremely high stress upon the gear train.

DO NOT employ the “snap break” method of breaking-out joints when pulling a string. The extremely high stress placed on the gear train frequently causes gear breakage and creates a safety hazard on the drill floor.

DO NOT USE THE “SNAP BREAK” METHOD TO BREAK OUT JOINTS

3.B MAKING AND BREAKING CONNECTIONS

THESE OPERATING PROCEDURES ASSUME THE USER HAS PROPERLY SET UP AND PREPARED THE EQUIPMENT FOR OPERATION AS PER SECTIONS 2E, 2F, AND 2G OF THIS MANUAL.

Set up and prepare your equipment for operation as per Section 2 of this manual Refer to the following sections:

- 2.E.3 - Hydraulic Connections
- 2.F - Tong Jaw Installation
- 2.G.1 - Tong Rig-up and Leveling (Suspension)
- 2.G.2 - Tong Rig-up and Leveling (Leveling)

Your tong and backup assembly should be properly suspended, connected to a hydraulic power source, and ready to make or break connections at this point.

3.B.1 Making A Connection

1. Ensure hydraulic power supply to the tong is energized. The master link on the rigid sling must be used to suspend the tong. Do not suspend the tong directly from the rigid sling.

ILLUSTRATION 3.B.1: MASTER LIFTING LINK

THE MASTER LINK MUST BE USED TO SUSPEND THE TONG ASSEMBLY

2. Ensure the backing pin is in the “makeup” position. From the front of the tong, the backing pin correctly configured for makeup will be in the 10 o’clock position (see Illustration 3.B.2 next page). If it is not, simply lift up and place in the correct position (see Illustration 2 next page). The cage plate opening must be aligned with the door opening when setting the backing pin position. Set the position of the backing pin on the backup in exactly the same fashion.

3.B.1 Making A Connection (Continued):

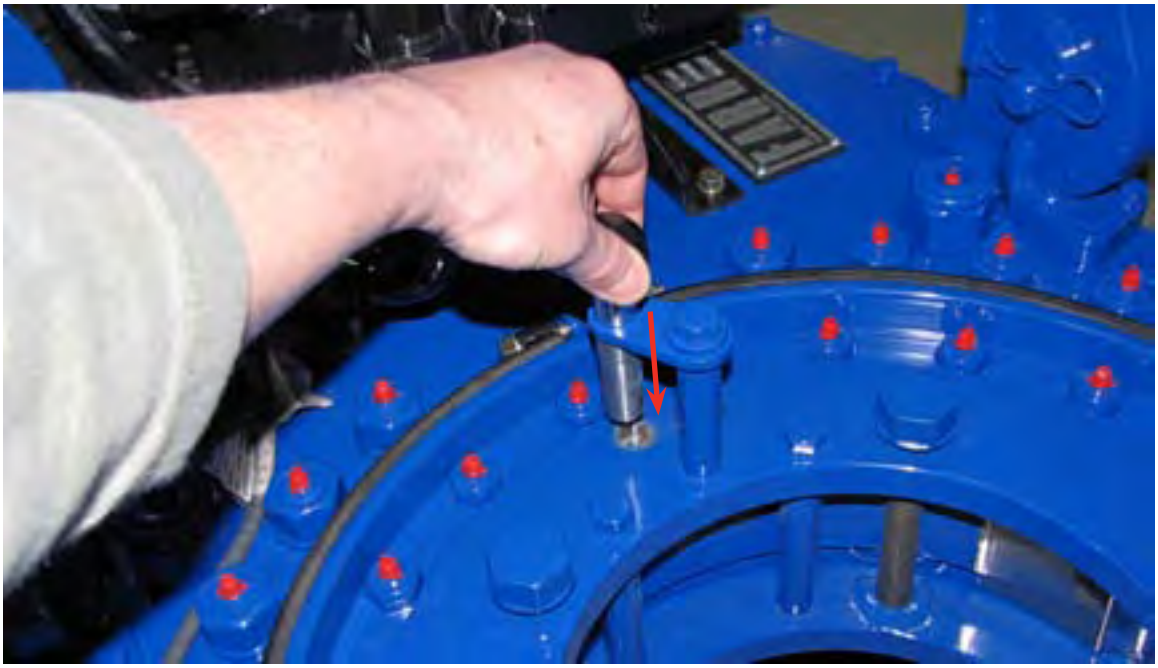

ILLUSTRATION 3.B.2: SETTING BACKING PIN TO "MAKE-UP" POSITION

3. Ensure the load cell and snub line(s) are properly configured for making up connections. The "snub line" is a length of wire rope that connects the rear of the tong body to a sturdy anchor on the drill floor (see Section 2.F.1). The snub line prevents the tong body from spinning in the opposite direction of the cage plate when torque begins to build in the joint. The snub line must be rated for the applied torque plus whatever safety margins stated by your own operating policies. The snub line connection point on the drill floor must be sturdy enough to absorb all applied forces when making up the joints. When making up joints the snub line is attached to the driller's side of the tong, which is the left side of the tong as seen from the rear. For accurate torque measurement the snub line must be perpendicular to the vertical, and perpendicular to the centre-line of the tong.
4. Actuate the lift cylinder control valve to lift the assembly from the drill floor. Pushing the valve toward the center of the tong will retract the lift cylinder to lift the assembly (see Illustration 2.H.3 below). Note that rig personnel are required to stabilize the tong and backup as it is being lifted so it does not swing and collide with other rig equipment.

RIG PERSONNEL MUST STABILIZE THE TONG AS IT IS LIFTED FROM THE DRILL FLOOR

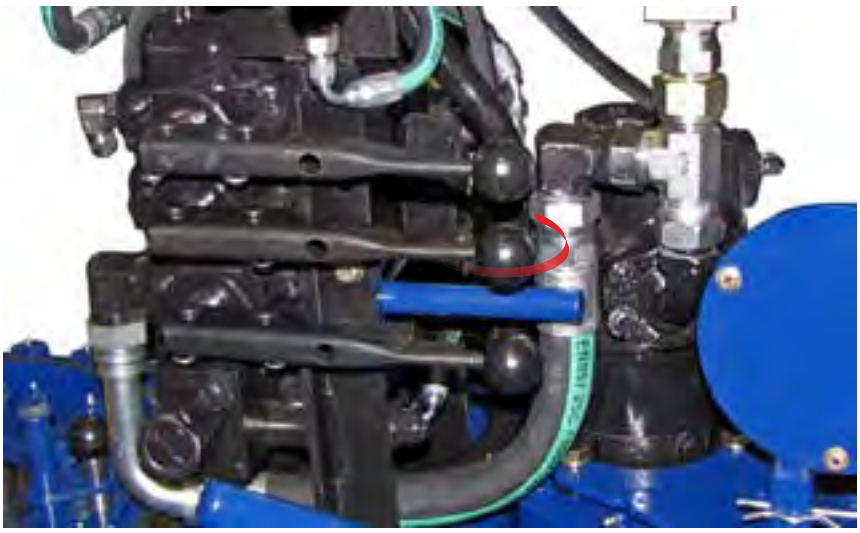

ILLUSTRATION 2.H.3: LIFT CYLINDER CONTROL - RAISE

3.B.1 Making A Connection (Continued):

5. Grasp the tong door handle and pull the door to open. Grasp the backup door handle and pull the door to open. Note that when standing in front of the assembly both doors open to the right. (see illustration 2.H.4). Since your equipment is equipped with a safety door, opening the door will inhibit rotation of the cage plate.

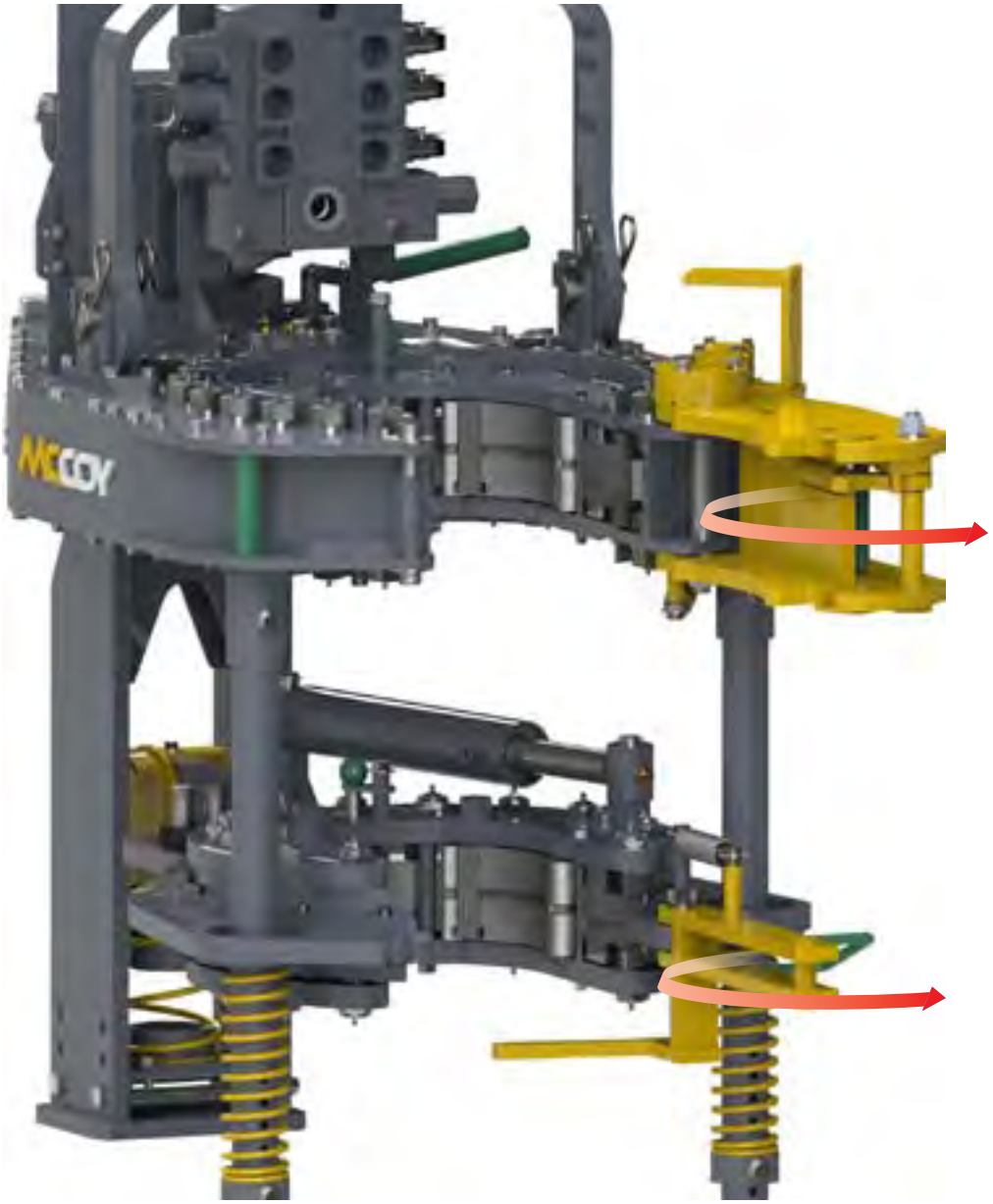

ILLUSTRATION 2.H.4: OPENING TONG & BACKUP DOORS

6. Manually engage the threads of the tubing connection being made up. Ensure threads are not cross-threaded.
7. Move the tong and backup assembly on to the tubing joint. Use the lift cylinder to ensure the tong jaws are at the correct location above the connection joint.
8. As the assembly is moved on to the joint the pipe will contact the "kicker bar" on the rear of the backup door, causing the backup door to close. Ensure backup door and tong door are fully closed against the latch posts.
9. Centre the joint roughly midway between the tong and backup jaws - rig personnel are required to stabilize the tong and backup around the connection until the jaws have been clamped shut. Actuate the backup clamping valve (push it toward the centre of the tong) to clamp the backup jaws on to the tubing below the connection point. Note that the backup control is "clamp and release", meaning that once the backup jaws are clamped, the jaws remain under clamping pressure until the operator manipulates the backup control handle to release pressure (see Illustration 2.H.5 next page).

3.B.1 Making A Connection (Continued):

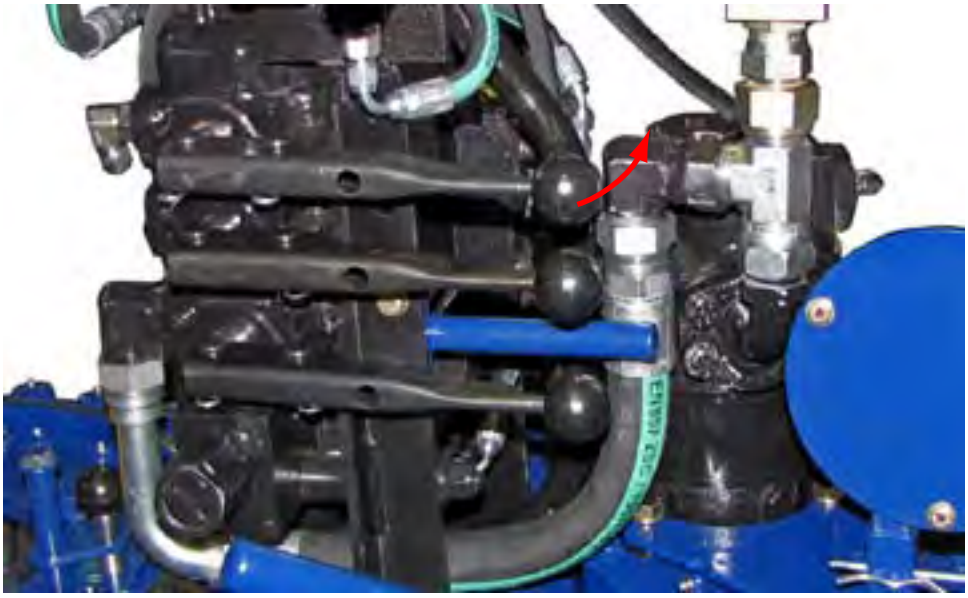

ILLUSTRATION 2.H.5: BACKUP CONTROL - CLAMP

10. Begin rotation with the tong in high gear and the tong motor set to high speed (high speed/low torque). See Section 2.G.2 to set the tong motor to high speed, and Section 2.G.3 to properly set the tong to high gear. Do not shift gears while the tong is rotating.

SHIFTING TONG WHILE ROTATING THE MOTOR AND CAGE PLATE MAY RESULT IN CATASTROPHIC GEAR TRAIN FAILURE

11. Push the motor control valve toward the tong to rotate the cage plate in the make-up direction.

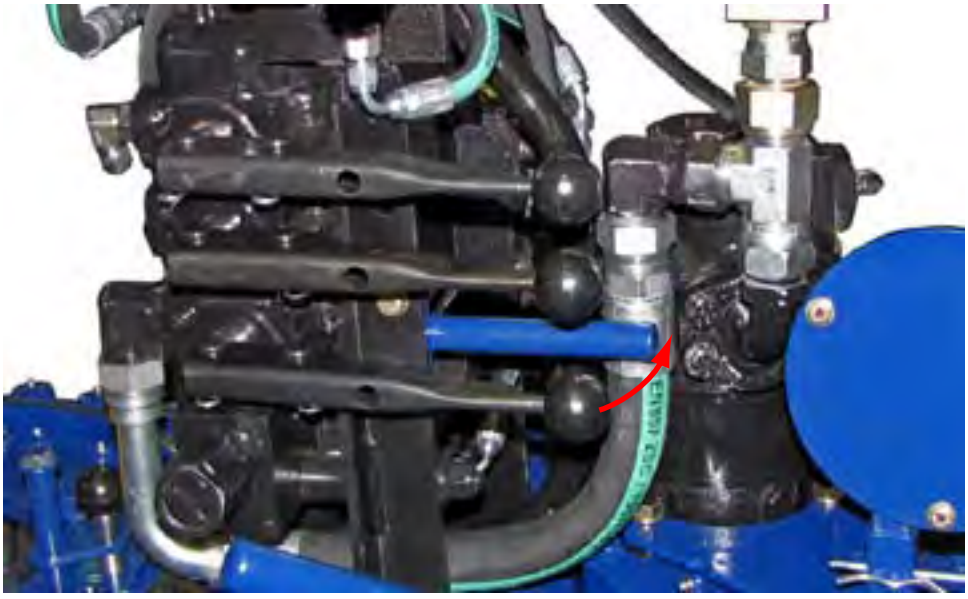

ILLUSTRATION 2.H.6: MOTOR CONTROL - MAKE-UP

12. When the tong jaws cam on to the tubing push the rotation control handle all the way in to thread the connection together at high speed. As the joint becomes fully made up the increasing torque demand will stall the motor, and displayed torque will increase.

3.B.1 Making A Connection (Continued):

13. Stop rotation, and set motor to low speed and shift to low gear (low speed/high torque - See Section 2.G.2 for instructions for setting motor to low speed, and Section 2.G.3 for shifting to low gear). This will enable the tong to produce adequate torque for making up the joint to specification.

14. Push the rotation control handle all the way in to complete the connection at low speed/high torque. Observe the torque gauge - when the specified make-up torque is reached stop rotation. If your equipment is equipped with dump valve, system pressure will "dump" to tank when the torque set-point is reached. Reverse the rotation control valve to release the tong jaws from the tubing (see Illustration 2.H.7).

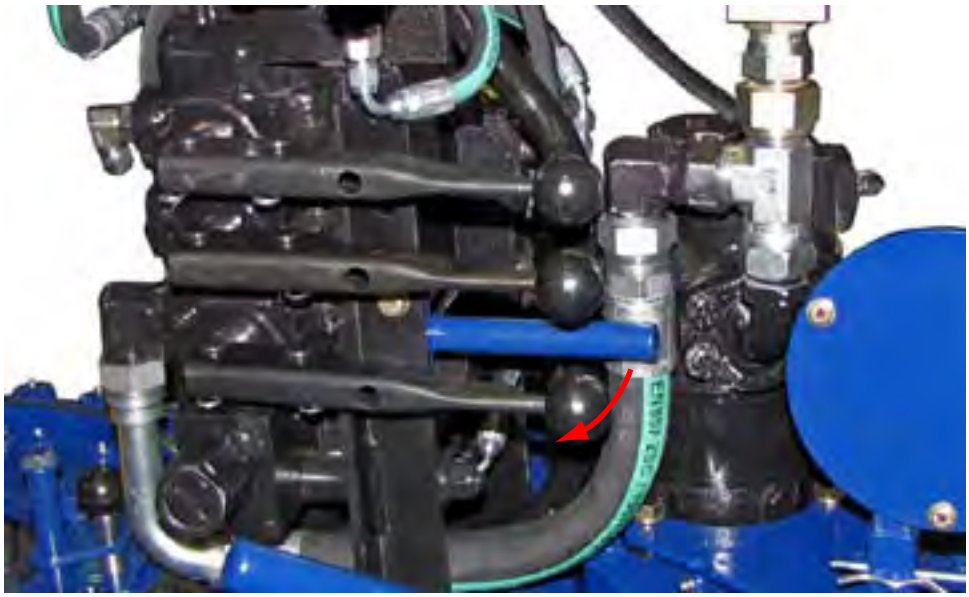

ILLUSTRATION 2.H.7: MOTOR CONTROL - RELEASING JAWS

15. When the tong jaws are freed release the backup jaws by pulling the backup clamp control handle away from the tong toward the operator.

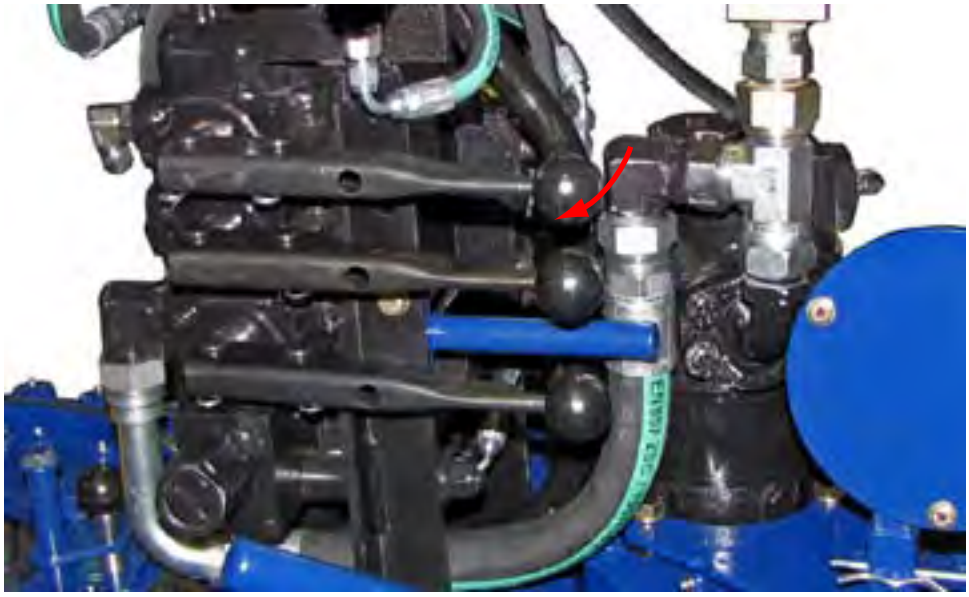

ILLUSTRATION 2.H.8: BACKUP CONTROL - RELEASING JAWS

3.B.1 Making A Connection (Continued):

16. When both sets of jaws are free, align the opening in the rotary gear with the mouth of the tong, and open the tong door, followed by the backup door. Opening the backup door will cause the tong and backup to "kick" away from the drill string. Note that rig personnel may be required to stabilize the tong as it completely releases from the drill string. Guide the tong away from the string and use the lift cylinder control to lower it to the drill floor if desired.

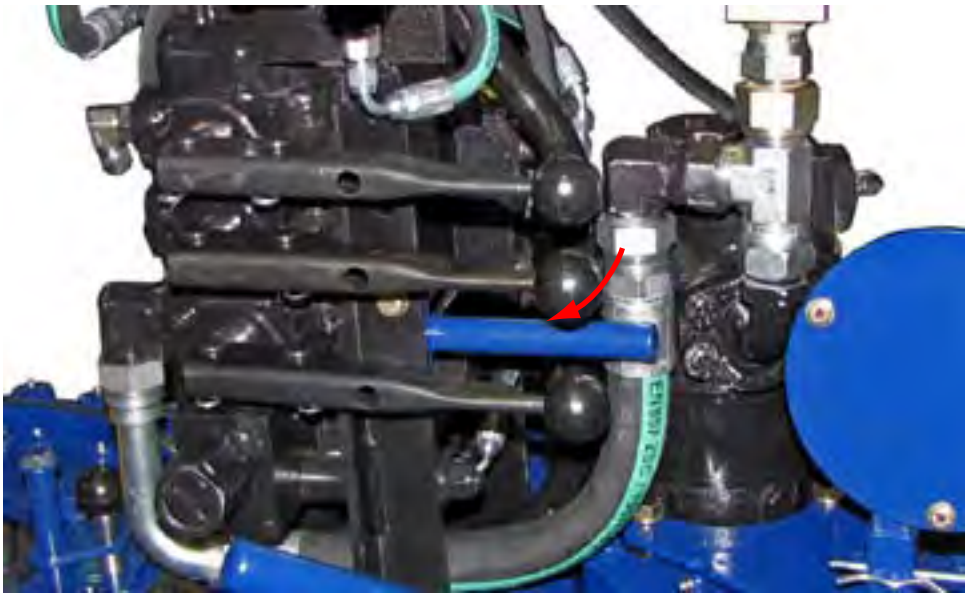

ILLUSTRATION 2.H.9: LIFT CYLINDER CONTROL - LOWER

17. Repeat steps "6" through "16" until the desired number of connections are made up.

3.B.2 Breaking A Connection

YOUR TONG SHOULD BE PROPERLY SUSPENDED, CONNECTED TO A HYDRAULIC POWER SOURCE, AND READY TO BREAK CONNECTIONS.

a) Ensure hydraulic power supply to the tong and backup is energized. The master link on the rigid sling must be used to suspend the tong. Do not suspend the tong directly from the rigid sling. See Illustration 2.H.1.

b) Set the backing pin on the tong AND backup for "breakout" operation. Lift up on the backing pin and rotate it to the "breakout" position, which is 2 o'clock as seen from the front of the tong. The opening in the rotary gear must be aligned with the tong door opening in order to properly set the backing pin (see Illustration 2.H.10). Set the position of the backing pin on the backup in exactly the same fashion.

ILLUSTRATION 2.H.10: SETTING BACKING PIN TO "BREAK-OUT" POSITION

3.B.2 Breaking A Connection (Continued):

c) Ensure the load cell is configured for break-out operation (see Section 2.F.3 for detailed instructions for configuring the load cell on your equipment).

d) Connect snub lines to the rear of the tong to arrest uncontrolled rotation of the assembly in the event of backup jaw slippage. The snub lines must be rated for the applied torque plus whatever safety margins stated by your own operating policies. The snub line connection points on the drill floor must be sturdy enough to absorb all applied forces

e) Open the tong and backup doors (see Illustration 2.H.4).

f) Actuate the lift cylinder control valve to lift the assembly from the drill floor if necessary. Pushing the valve toward the center of the tong will retract the lift cylinder to lift the assembly (see illustration 2.H.3). Note that rig personnel are required to stabilize the tong and backup as it is being lifted so it does not swing and collide with other rig equipment. Move the tong and backup on to the string.

RIG PERSONNEL MUST STABILIZE THE TONG AS IT IS LIFTED FROM THE DRILL FLOOR

g) As the assembly is moved on to the drill string the pipe will contact the “kicker bar” on the rear of the backup door, causing the backup door to close. Firmly close the tong door against the latch post.

h) Ensure tubing is roughly centered within the tong and backup jaws - rig personnel are required to stabilize the tong and backup around the connection until the jaws have been clamped shut. Actuate the backup clamping valve (push it toward the centre of the tong) to clamp the backup jaws on to the tubing below the connection point. Note that the backup control is “clamp and release”, meaning that once the backup jaws are clamped, the jaws remain under clamping pressure until the operator manipulates the backup control handle to release pressure (see Illustration 2.H.5).

i) Breakout torque is only available when tong motor speed is set to low speed and tong is in low gear. See Section 2.G.2 to set tong to low speed and Section 2.G.3 to shift to low gear. Do not shift gears while the tong is rotating.

SHIFTING TONG WHILE ROTATING THE MOTOR AND CAGE PLATE MAY RESULT IN CATASTROPHIC GEAR TRAIN FAILURE

m) Gently pull the motor control valve toward the operator to cam the tong jaws on to the pipe.

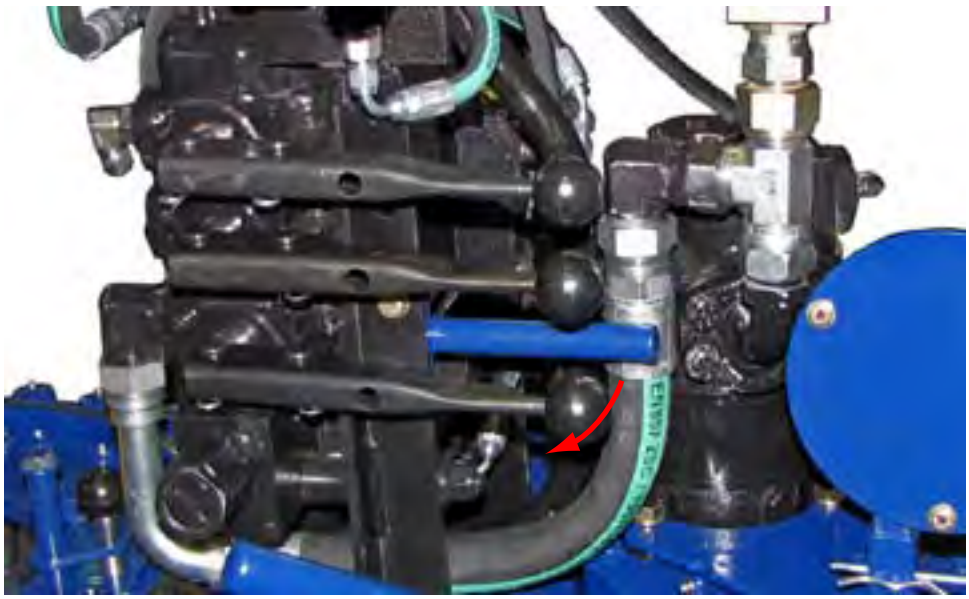

ILLUSTRATION 2.H.11: ROTATION CONTROL - BREAKOUT

k) When the tong jaws cam on to the tubing pull the rotation control handle all the way out to break the connection.

l) When the connection breaks stop rotation, set tong motor to high speed and shift to high gear (see Section 2.G.2 to set motor speed and 2.G.3 to shift to high gear). This will enable the tong to completely un-thread the connection at high speed.

3.B.2 Breaking A Connection (Continued):

m) Pull the rotation control handle all the way out to completely un-thread the connection. Reverse the rotation control handle (push toward tong) to release the tong jaws from the tubing.

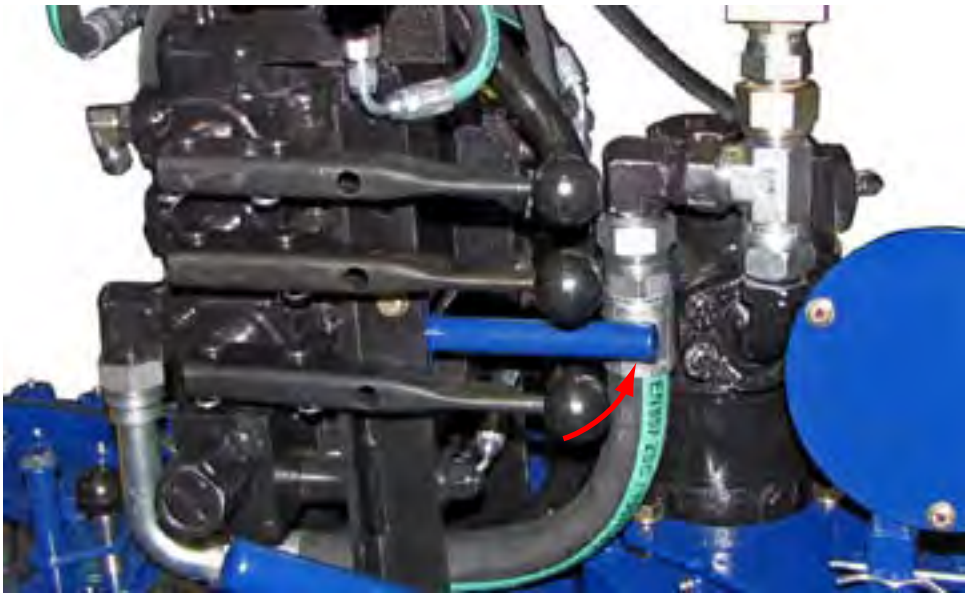

ILLUSTRATION 2.H.12: USING MOTOR CONTROL TO RELEASE TONG JAWS FOLLOWING BREAK-OUT & UN-THREADING

n) When the tong jaws disengage align the opening in the rotary gear with the mouth of the tong, and open the tong door to free the tong from the drill string. Unlatch and open the tong door to free the assembly from the tubing. Opening the backup door will cause the tong and backup to "kick" away from the drill string. Note that rig personnel may be required to stabilize the equipment as it completely releases from the tubing. Guide the assembly away from the string and use the lift cylinder control to lower it to the drill floor if desired.

RIG PERSONNEL MUST STABILIZE THE TONG AS IT IS LOWERED TO THE DRILL FLOOR

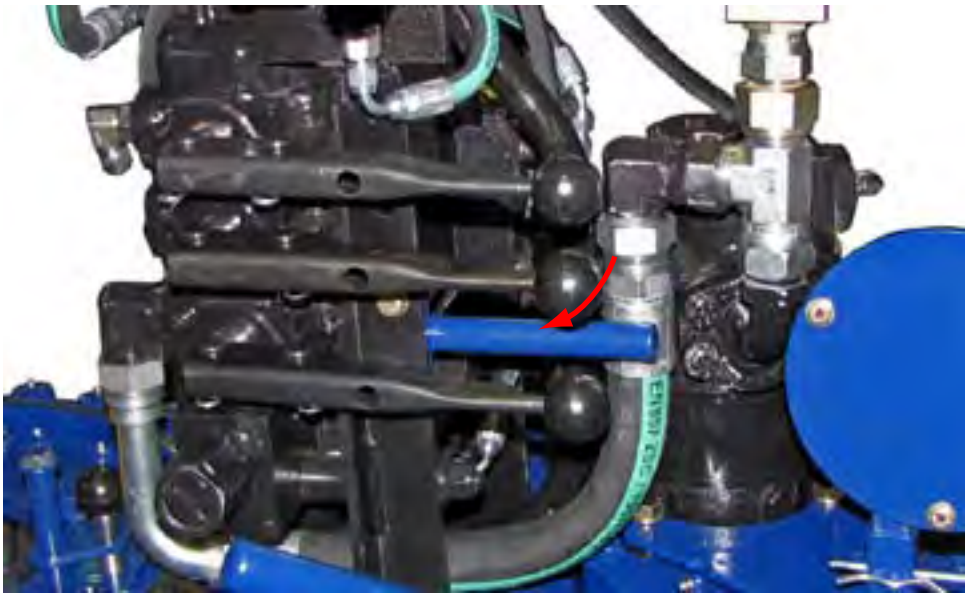

ILLUSTRATION 2.H.13: LOWERING TONG & BACKUP USING LIFT CYLINDER CONTROL

o) Use your rig's standard pipe handling procedures to remove and rack the freed tubing stand.

p) Repeat steps "e" through "o" as many times as necessary to break out and un-thread the desired number of connections.

3.C EXTREME COLD WEATHER OPERATION PROCEDURES

1) Consult the power unit engine operator's manual for all cold weather operating procedures and precautions.
2) Select gear and bearing lubricants that are compatible with expected climatic conditions.
3) Select hydraulic fluid that is compatible with expected climatic conditions.
4) Allow hydraulic fluid to circulate for approximately 20 minutes after starting the power unit, prior to activating the bypass valve to allow fluid to circulate to tong. If the power unit is equipped with an oil temperature gauge, ensure that the fluid has reached operating temperature as specified by hydraulic fluid data sheet.
5) Allow for adequate drying of moisture (prior to lubricating) when cleaning tong parts in cold weather.

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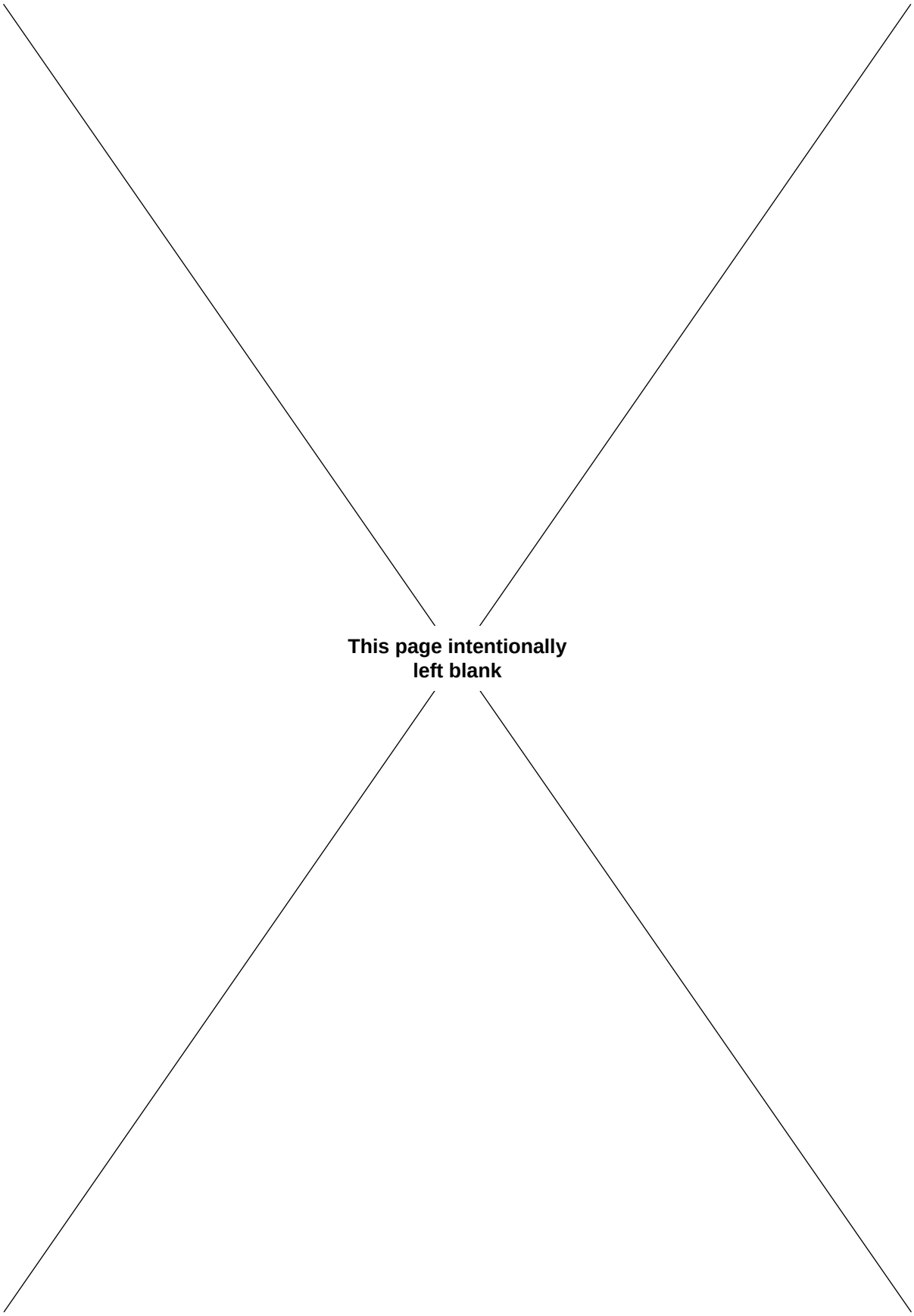
SECTION 4: MAINTENANCE



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McCoy Completions & Drilling recognizes that minor on-site repairs and modifications are required to maintain peak operating condition of your equipment, or to match your equipment with the operating environment. Examples of minor repairs are

- replacement of damaged hydraulic hoses and fittings.
- replacement of malfunctioning pressure gauges and valves.
- replacement of door cylinders
- replacement of fasteners

Any replaced component must be an identical component supplied by McCoy Completions & Drilling. Replaced fasteners must be Grade 8 or equivalent, or whatever fastener is specified by McCoy.

4.A GENERAL MAINTENANCE SAFETY PRACTICES

The practices identified here are intended as a guideline. All personnel are responsible for performing their tasks in a manner that ensures worker, equipment, and environmental safety, and may require taking additional steps that are not identified in this section.

Equipment maintenance shall be performed only by designated qualified maintenance personnel. Wear approved eye wear and footwear, and follow all of your company's safety guidelines Do not begin a maintenance task without the proper tools or materials on hand, or the proper drawings and documentation necessary.

Schedule planned maintenance with operators to avoid conflicts, unnecessary downtime, and the danger of accidental equipment activation. Notify operations when maintenance procedures are complete and equipment functionality is restored.

Isolate the location of the maintenance under way to prevent unaware personnel from inadvertently exposing themselves to a hazard. Use tape, rope, or signage to clearly indicate "off-limits" area.

Replacement of large, heavy individual parts and/or heavy structural components must be performed using an approved lifting device of sufficient lifting capacity. Use care when attaching the lifting device, and safeguard area to avoid endangering personnel or equipment.

All spare parts must meet or exceed OEM specifications in order to maintain equipment integrity, especially protective equipment

McCoy recommends that disconnection of hydraulic connectors be performed with the power unit off and the hydraulic circuit depressurized.

Your equipment uses materials that may be harmful to the environment if improperly disposed of (hydraulic fluid, grease, etc.). Dispose of all materials according to your company's proscribed environmental protection regulations.

4.B CLEANING

Clean tong thoroughly cleaned with a good petroleum-based cleaning agent after each job, prior to storage. Farr recommends that the motor and valve assembly be periodically removed, along with the top tong plate, so that guides, rollers and gears can be properly cleaned. Ensure that cleaning solvents and chemicals are captured to prevent environmental contamination, and dispose of all materials according to your company's proscribed environmental protection regulations.

4.C PREVENTIVE MAINTENANCE

Regular maintenance programs are necessary, and must be established to assure safe, dependable operation of your Hydraulic Tubular Connection System and to avoid costly breakdown maintenance. The following maintenance procedures provide information required to properly maintain your equipment. Your equipment may require more, or less maintenance depending upon the frequency of use and the field conditions under which your equipment operates. McCoy has also provided recommended maintenance checklists. The intervals in the maintenance checklists are designed for equipment operating at 10°C to 35°C ambient temperature for 10 hours per day. McCoy recommends that the inspection and maintenance procedures in this section be performed as recommended in the maintenance checklists, or in conjunction with your maintenance foreman's experience and best estimate of when your equipment is due for this maintenance.

Purchased components included with your hydraulic tubular connection equipment (for example: motors, valves, etc.) may specify maintenance tasks and intervals over and above what McCoy recommends as part of their recommended procedures. Users of this equipment may choose to perform or ignore these additional tasks at their discretion.

Premature fouling of particulate filters within your prime mover or ancillary hydraulic power unit requires immediate hydraulic fluid laboratory analysis to prevent premature wear of hydraulic system due to high levels of wear metals in the fluid.

McCoy Completions & Drilling recommends tracking all maintenance activity including the lubrication schedule. This may be a simple as keeping a paper log, or using a software-based maintenance tracking utility. A maintenance log is a valuable tool that can be used for easily retrieving maintenance history or identifying trends that require correction.

4.D HYDRAULIC SYSTEM DE-PRESSURIZATION

McCoy Drilling & Completions recommends that the hydraulic system be de-pressurized prior to maintenance on any hydraulic component. Perform the following steps to ensure the dangers posed by hydraulic fluid under pressure are minimized.

ENSURE ADEQUATE CONTAINMENT IS IN PLACE TO PREVENT ENVIRONMENTAL CONTAMINATION FROM RESIDUAL HYDRAULIC FLUID

1. Rotate the tong to the "open throat" position. Ensure tong and backup doors (if equipped) are closed. Fully extend the lift cylinder
2. De-energize the power unit.
3. Repeatedly actuate the tong motor control valve lever IN BOTH DIRECTIONS to dissipate any residual pressure in the valve and motor.
4. Remove the hydraulic SUPPLY line from the equipment.
5. Repeatedly actuate the remaining control valve levers IN BOTH DIRECTIONS to dissipate any residual pressure in the remainder of the hydraulic control system.
7. Disconnect the hydraulic RETURN line from the equipment.
8. Disconnect remaining hoses such as case drains, or lines connected to the turns counter.

HYDRAULIC PRESSURES AS HIGH AS OPERATING PRESSURE MAY REMAIN TRAPPED IN SMALL AREAS OF THE EQUIPMENT. ENSURE ALL MAINTENANCE IS CARRIED OUT BY A QUALIFIED SERVICE TECHNICIAN, AND THAT ADEQUATE PERSONAL PROTECTIVE EQUIPMENT IS USED TO GUARD AGAINST PRESSURE INJURIES

4.E LUBRICATION INSTRUCTIONS

Use a quality multipurpose bearing lubricant that will remain within its viscosity range at expected operating temperatures. In addition, Farr recommends the following lubrication procedure at the completion of each job prior to storage.

McCoy recommends that a liberal coating of grease be applied to the cam surface of the rotary drive gear prior to jaw installation. Also, the clutch inspection plate should periodically be removed, and a liberal coating of grease applied to the clutch, drive gears and shifting shaft.

Coat the jaw pins and rollers with a liberal amount of anti-seize compound when installing new jaw die kits.

4.E.1 Cam Followers

Lubricate cam followers mounted in the cage plate and in the body plates surrounding the rotary gear through the grease fittings in the ends of the cam followers (76 locations - see illustration 3.E.1).

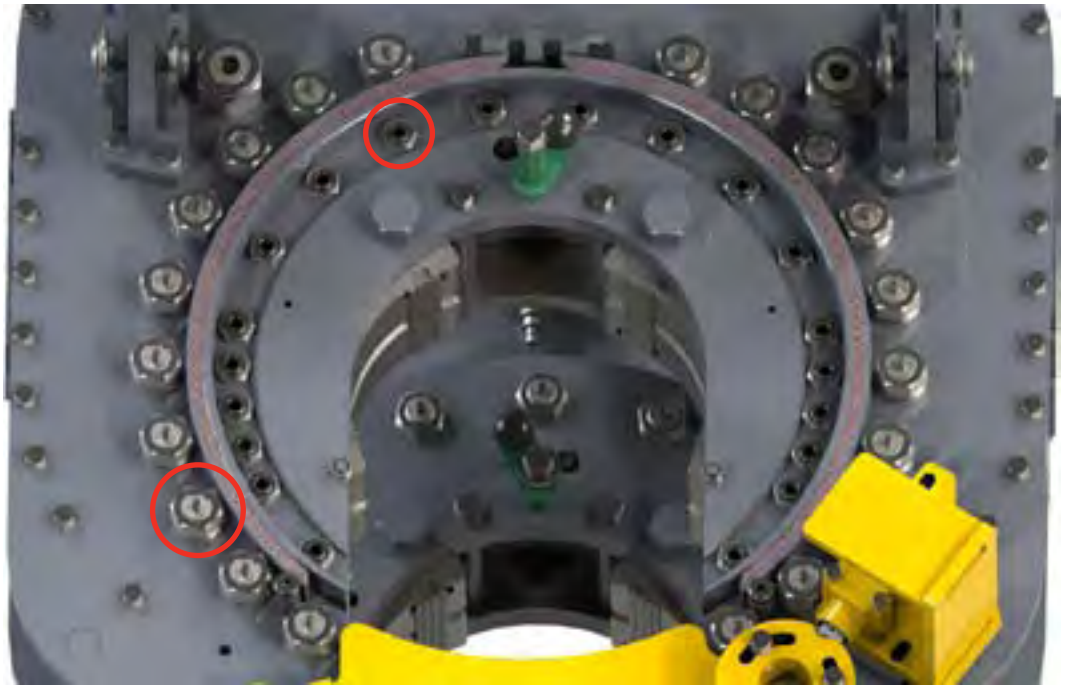

ILLUSTRATION 4.E.1: CAM FOLLOWER LUBRICATION

4.E.2 Rotary Idler Bearings

Apply grease to these bearings through the grease fittings in the ends of the rotary idler shafts, located on the top of the tong to the inside of each rigid sling weldment (2 locations total).

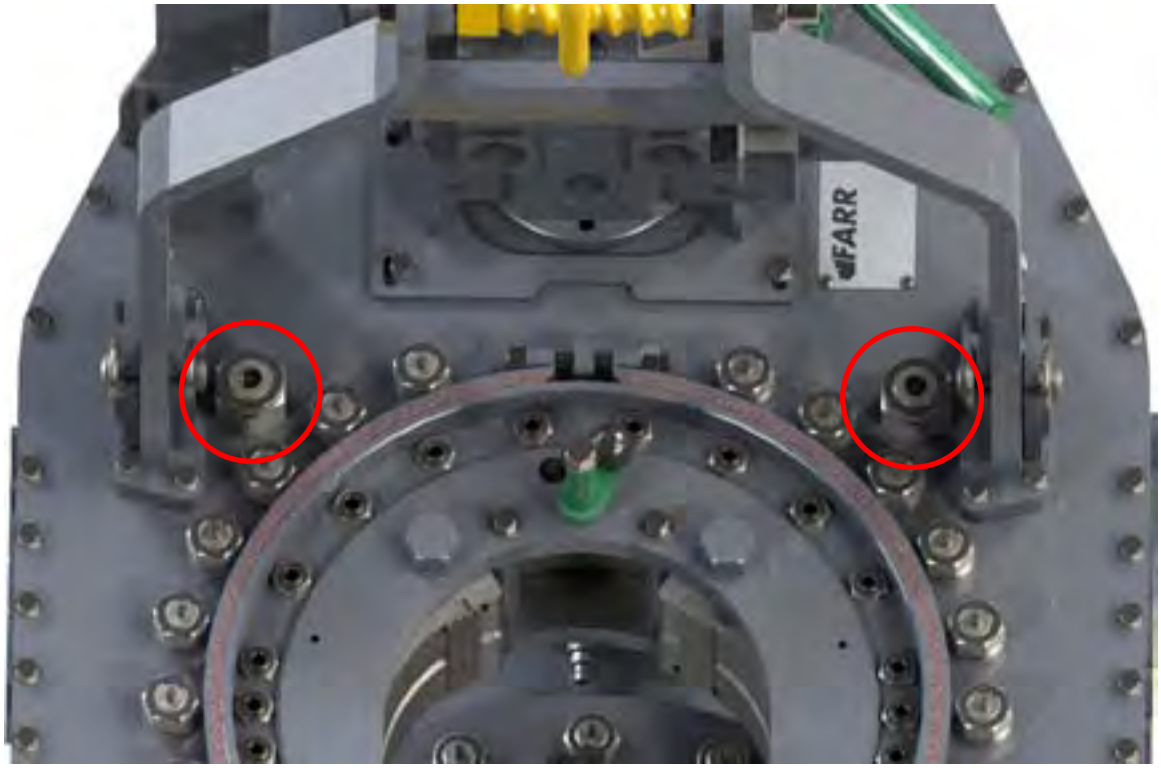

ILLUSTRATION 4.E.2: ROTARY IDLER LUBRICATION

4.E.3 Pinion Idler Bearings

Apply grease to these bearings through the grease fittings in the ends of the pinion idler shafts, located on the bottom of the tong on each side of the stiffener plate, just behind the brake band (2 locations total).

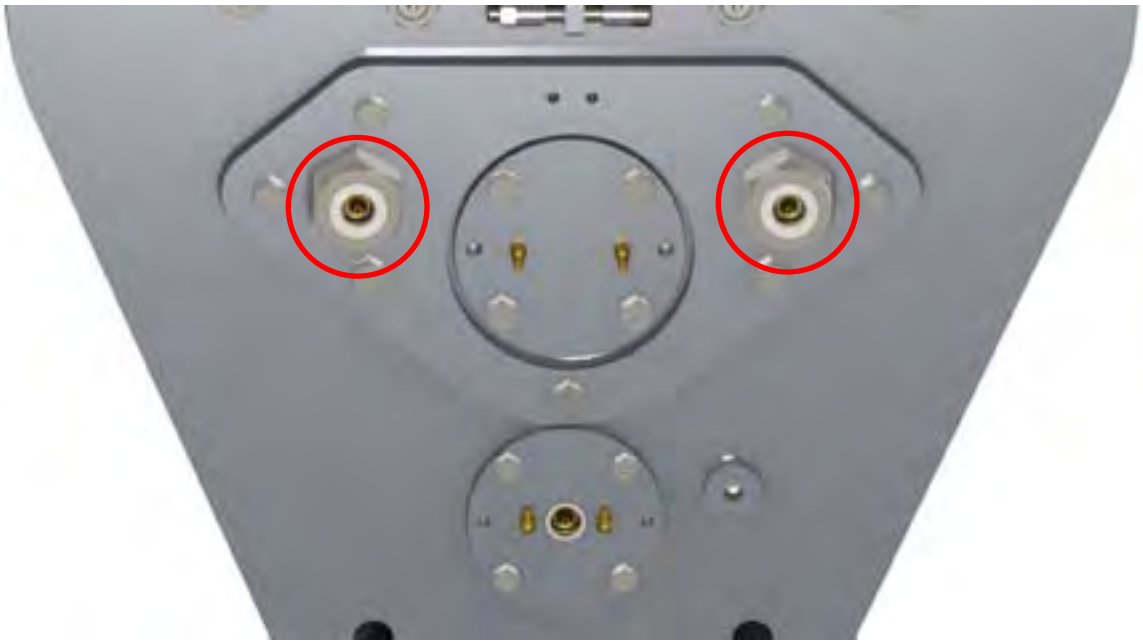

ILLUSTRATION 4.E.3: PINION IDLER LUBRICATION

4.E.4 Pinion Bearings

Apply grease to these bearings through the grease fittings in the pinion bearing caps located on the top of the tong directly beneath the valve bank, and on bottom of the tong in the center of the stiffener plate (total of four locations).

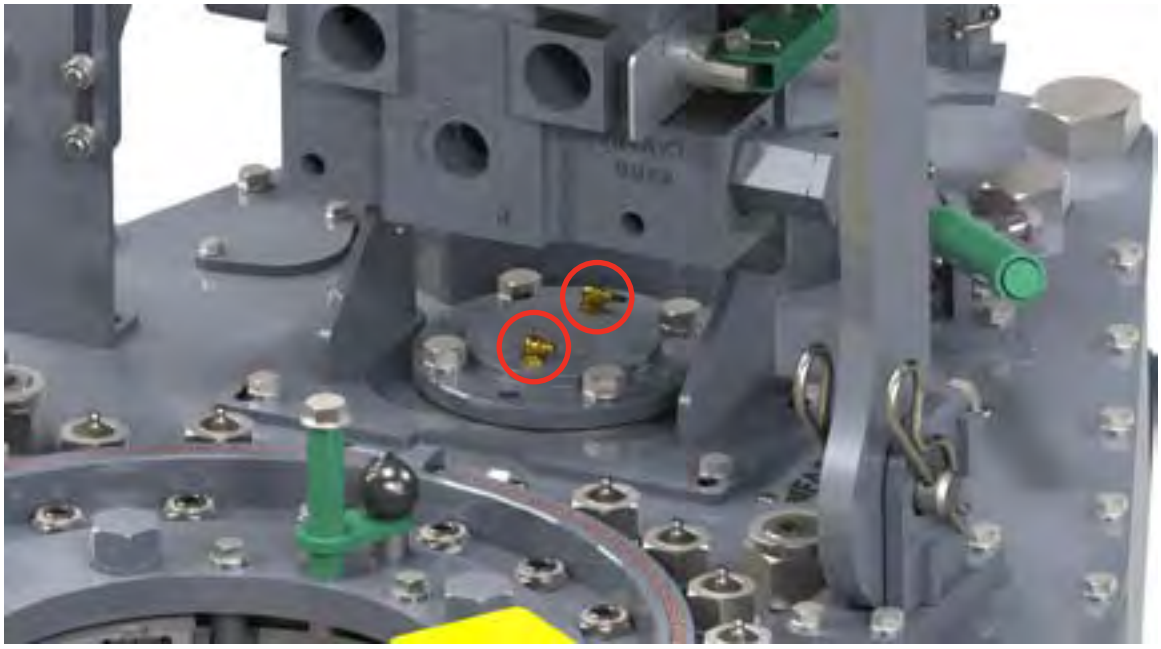

ILLUSTRATION 4.E.4: PINION LUBRICATION (TOP PLATE)

ILLUSTRATION 4.E.5: PINION LUBRICATION (BOTTOM PLATE)

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4.E.5 Clutch Bearings

Apply grease to the clutch and clutch shaft bearings through three grease fittings in the clutch bearing cap, which is located on the bottom plate. Note that the centre grease fitting is recessed into the end of the clutch shaft.

ILLUSTRATION 4.E.6: CLUTCH LUBRICATION

4.E.6 Motor Mount Housing

Apply grease to the gears in this housing through the two grease fittings on the bearing cap on top of the motor mount, in the area indicated by the red circle.

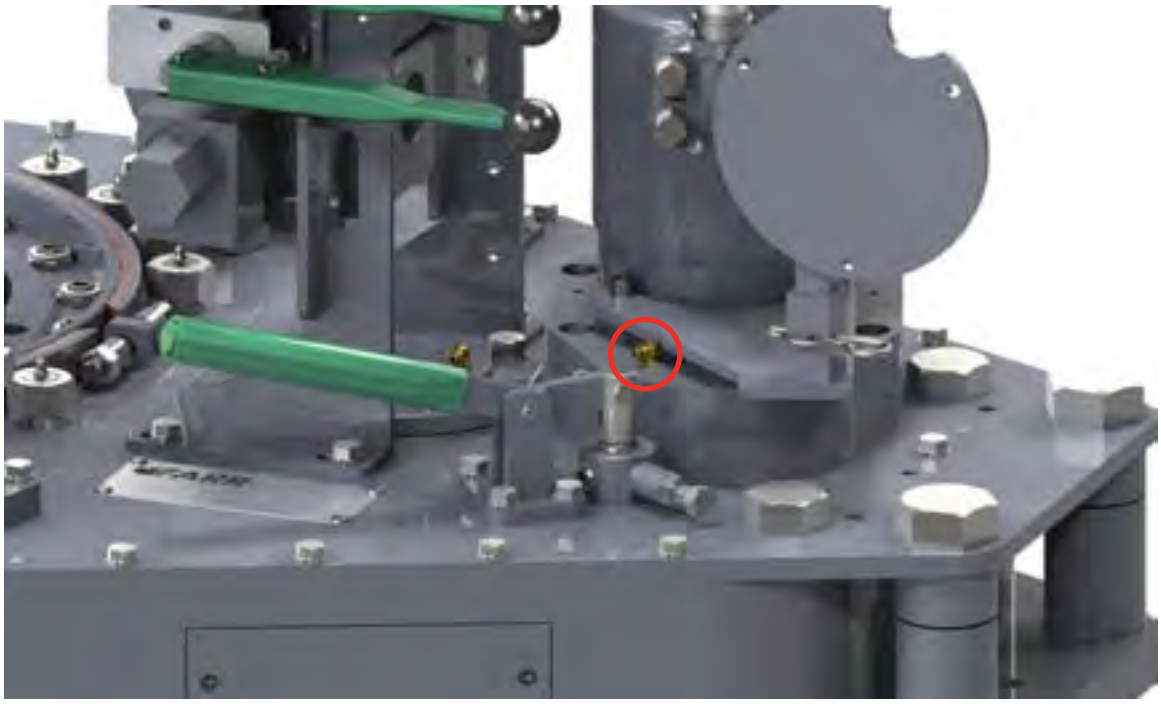


ILLUSTRATION 4.E.7: MOTOR MOUNT LUBRICATION

4.E.7 SHIFTING SHAFT

Apply grease to the shifting shaft and shifting shaft bushings, accessed through the cover plate on the side of the tong, near the rear.

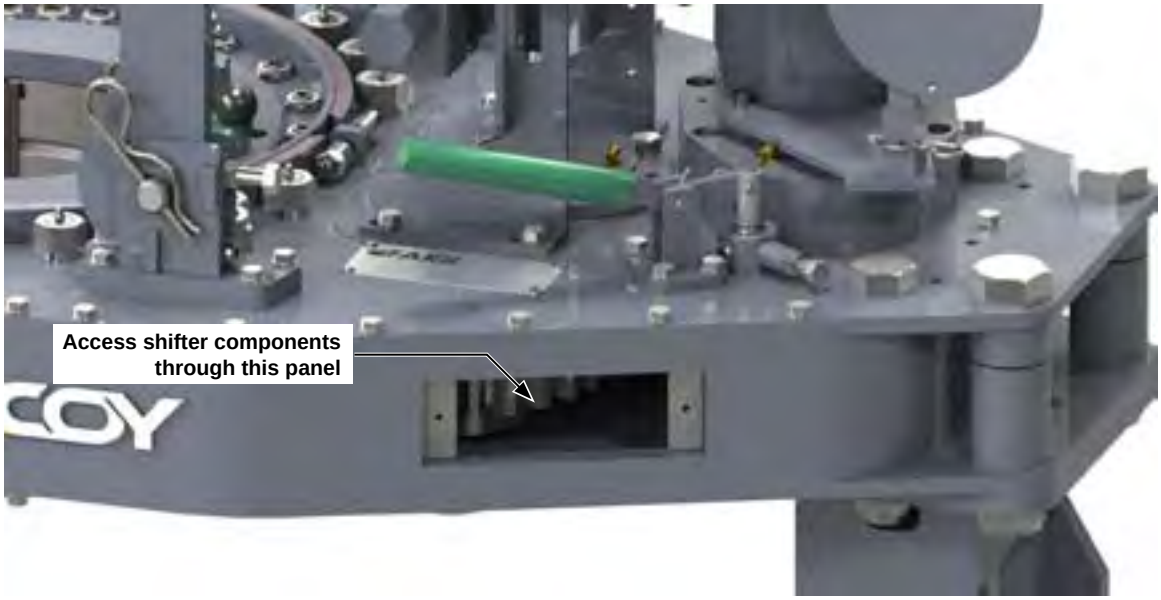


ILLUSTRATION 4.E.8: SHIFTER SHAFT LUBRICATION

4.E.8 Door Latch Claw

Apply a small amount of grease to the door latch claw as necessary in order to maintain smooth operation.

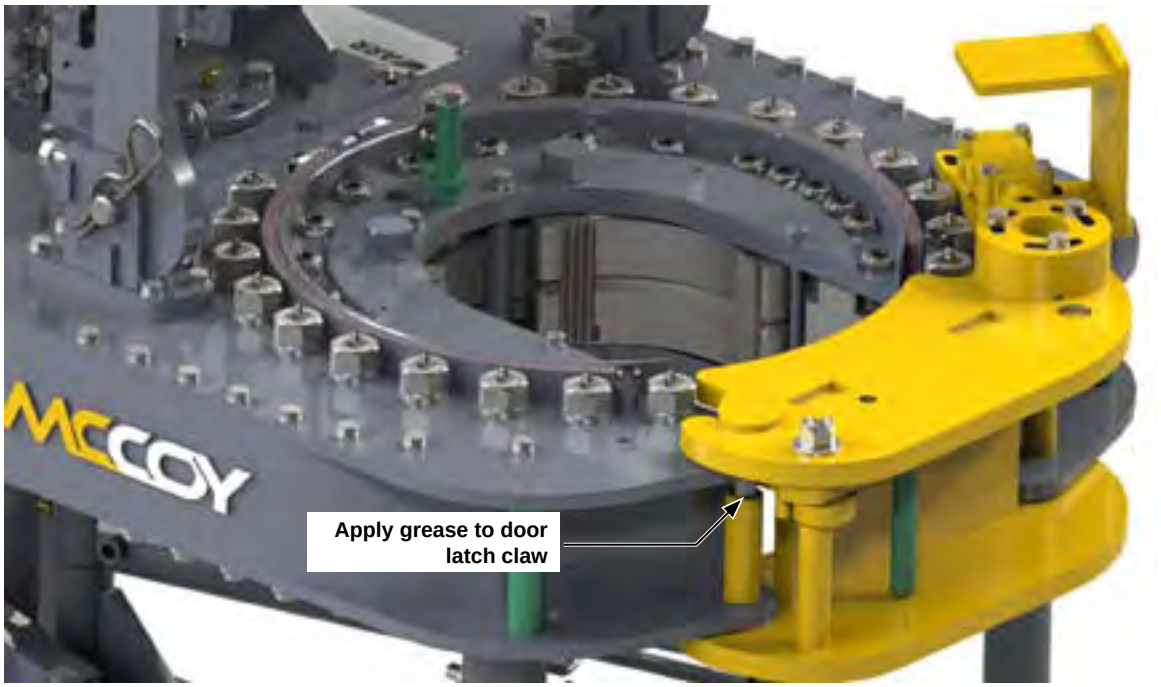


ILLUSTRATION 4.E.9: DOOR LUBRICATION

4.E.9 BACKUP ROTARY / CAM FOLLOWER LUBRICATION

Apply grease to the cam followers through the grease fittings recessed into the top and bottom cage plate (sixteen locations top, sixteen locations bottom).

ILLUSTRATION 4.E.10: BACKUP ROTARY CAM FOLLOWER LUBRICATION

4.E.10 BACKUP CLAMP CYLINDER LUBRICATION

Apply grease to the clamp cylinder pivots through the grease fittings at each end of the cylinder.

ILLUSTRATION 4.E.11: BACKUP CLAMP CYLINDER LUBRICATION

4.E.11 DOOR STOP CYLINDER

Periodically disassemble the door stop cylinders and coat the spring and cylinder with a general purpose lubricating oil.

ILLUSTRATION 4.E.12: DOOR CYLINDER

4.F ADJUSTMENTS

4.F.1 Brake Band Adjustment

The top and bottom brake bands must be periodically adjusted to continue to provide smooth and efficient jaw cam action. If the cage plate turns with the rotary gear, the jaws will not cam properly and, therefore, will not bite on the tubing or casing. Tightening the brake band against the cage plates will increase frictional resistance, allowing jaws to cam properly and grip the casing. Adjust the brake band using the adjustment nut and bolt set as shown in the illustration below. Use caution, as over-tightening will cause excessive wear to the brake bands.

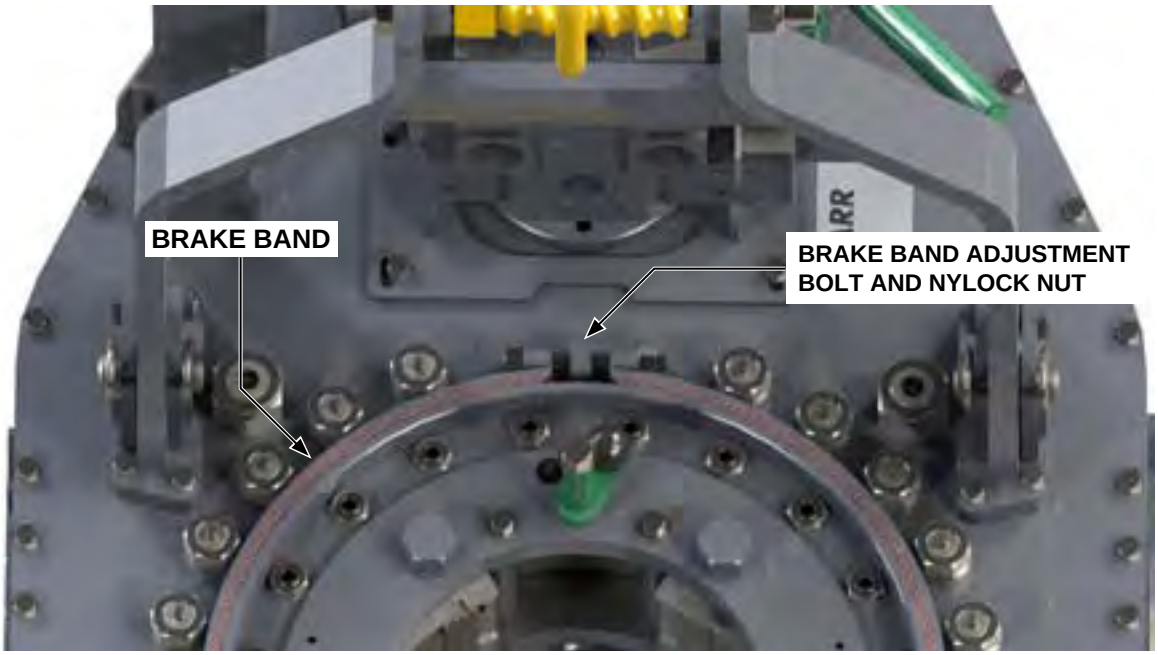


ILLUSTRATION 4.F.1: BRAKE BAND ADJUSTMENT

4.F.2 Shifter Detent Force Adjustment:

Over time wear to the shifting shaft, wear to the detent ball, and loss of spring tension in the detent spring may result in a loose or "sloppy" fit within the top shifter bushing. The detent pressure may be increased or otherwise adjusted by loosening the 7/16" UNF locking jam nut, and turning the 7/16" UNF detent bolt. Should adequate detent action not be achieved, the shifting shaft, detent ball, or detent spring (or possibly all three) may need to be replaced (see Pp. 6.18 - 6.19).

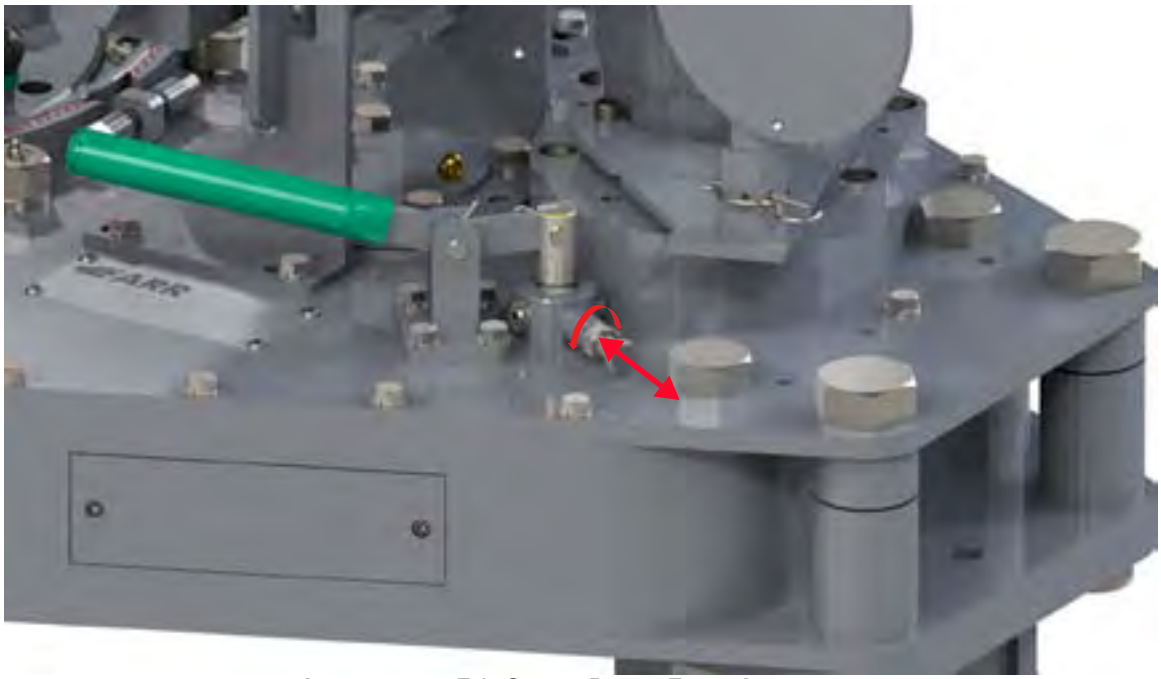


ILLUSTRATION 4.F.2: SHIFTER DETENT FORCE ADJUSTMENT

4.F.3 Safety Door Switch Adjustment

The safety door switch should interrupt hydraulic power to the motor when the tong door is opened, or even slightly ajar. This is a critical safety system, and proper adjustment is necessary to maintain the intended function. If the rotary gear does not stop immediately and completely stop rotating when the door is opened, remove the tong from service and perform the adjustments in this section. Over time, normal use of the equipment may result in a worn switch plunger or worn door where it contacts the switch plunger, resulting in enough clearance between the switch plunger and the door to cause the hydraulic switch to engage and inhibit tong rotation even with the door closed. This procedure will enable the equipment user to re-establish the proper tolerances between the switch and the door to allow the safety door system to operate as designed.

1. Set the tong up in a controlled testing environment. Do not connect hydraulic power at this time.
2. Open the tong door and check operation of the safety door switch plunger. Depress and allow it spring back several times to ensure smooth operation. If the plunger binds or jams, replace the safety door switch.

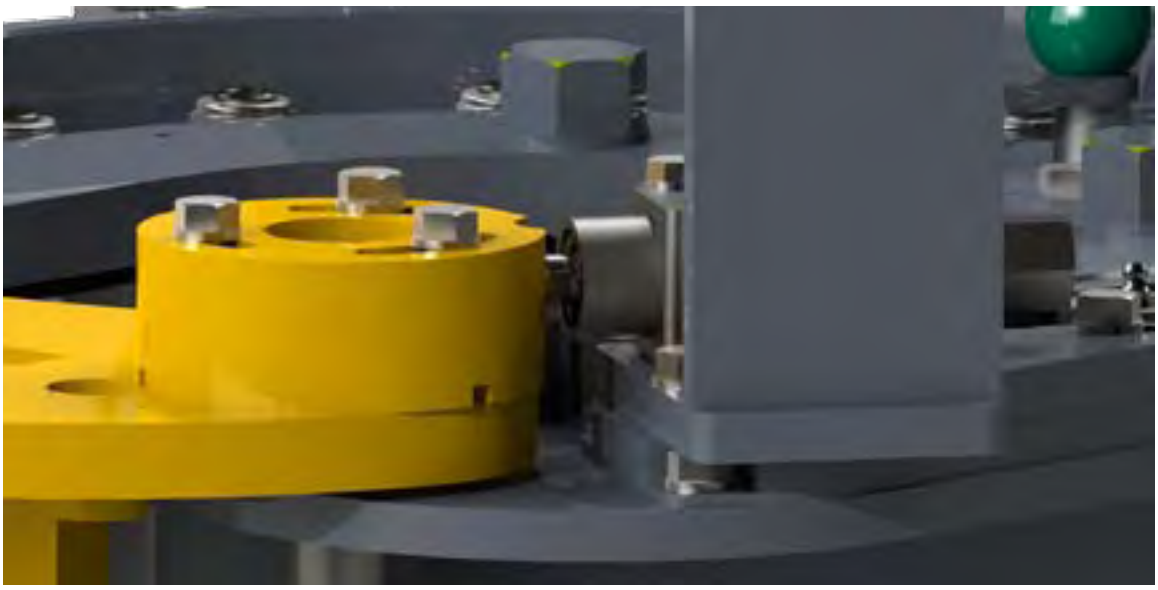


ILLUSTRATION 4.F.3: SAFETY DOOR ADJUSTMENT 01

3. If necessary, align the notch on the safety door cam with the safety door switch plunger. Loosen the three bolts securing the safety door cam to the door plate and rotate until the notch in the cam is centered on and in full contact with the plunger of the safety door switch.

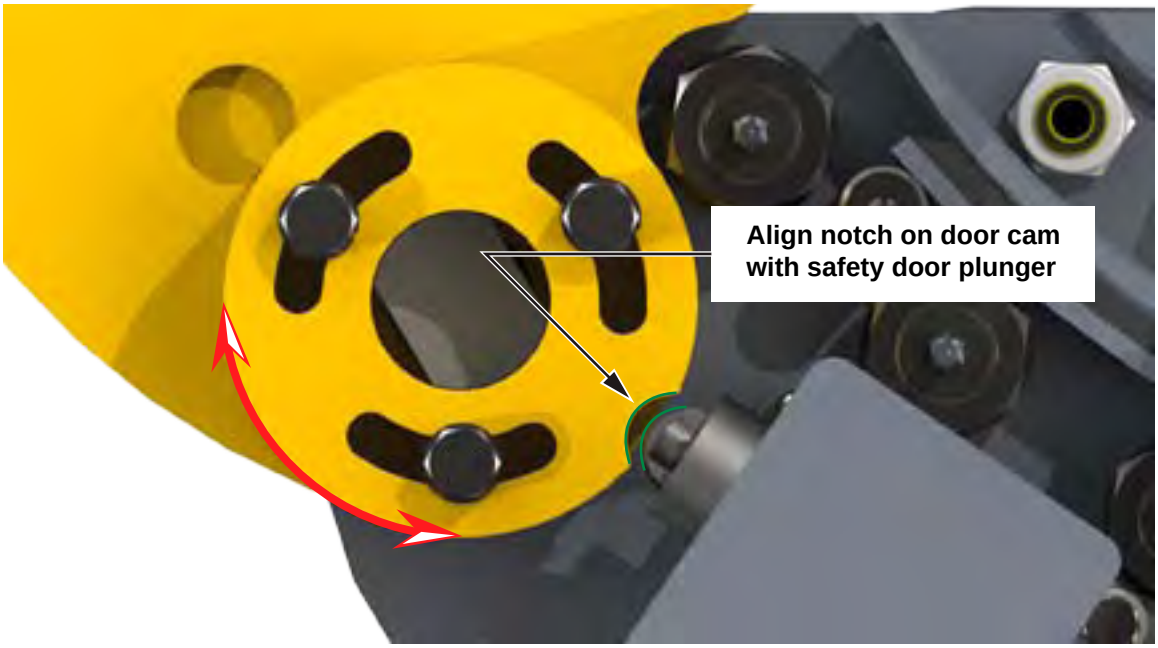


ILLUSTRATION 4.F.4: SAFETY DOOR ADJUSTMENT 02

4.F.3 Safety Door Switch Adjustment (Continued):

4. Connect hydraulic power to the tong.
5. Ensure the door is closed and all personnel are clear. Begin rotating the cage plate. Open the tong door - the cage plate should immediately and completely stop.
6. Release all controls, and close the tong door again. Ensure the cage plate rotates with the door closed.
7. If cage plate continues to rotate with the door open, further adjustment of the safety door switch is necessary. Remove hydraulic power from the tong.
8. Lateral adjustment is achieved by adjusting the position of the safety door switch mounting block/guard weldment. Loosen the three mounting bolts on the weldment slightly. Use a hammer to lightly tap the weldment approximately 1/16" (2 mm) toward the door cam. Retighten the mounting bolts.

ILLUSTRATION 4.F.5: SAFETY DOOR ADJUSTMENT 03

9. Repeat steps 5 through 7. If the safety door mechanism operates correctly and no further adjustment is required this procedure is complete. If further adjustment is required, repeat steps 8 and 9 until the safety door mechanism operates correctly. If your equipment reaches the adjustment limits before correct operation of the safety door mechanism is achieved contact the engineering department at McCoy Drilling & Completions | FARR for further technical advice.

4.G RECOMMENDED PERIODIC CHECKS

4.G.1 Door Stop Spring

The spring inside the actuator cylinder must be of sufficient strength to enable the door latch mechanism to snap closed properly, and to hold the door in the open position when opened. Door stop spring fatigue will result in sluggish latch operation. Replace the latch spring inside the cylinder when this occurs.

4.G.2 Backing Pin

Perform a visual inspection of the backing pin after each job. Replace the pin if stress cracks or excessive wear is found, or if either pin is bent.

4.G.3 Shifting Shaft

The shifting yoke is secured to the shifting shaft by one hex jam nut above the shifting yoke, and one locknut on the bottom of the yoke. Check these nuts after each job. Do this by removing the clutch inspection plate and ensuring a snug fit prior to lubrication.

4.G.4 Torque Gauge Assembly

Periodic calibration of the torque gauge is recommended to assure accurate torque readings. When having the torque gauge serviced and calibrated, it is critical to note the arm length of the tong, as indicated in the "Specifications" section. Farr recommends that the torque gauge assembly be calibrated yearly. Periodically check to ensure the load cell is filled with oil (see Section 6).

4.H REMOVAL OF TOP PLATE FOR OVERHAUL

Overhaul of the power tong requires removal of the top plate for access to the gear train. Remove the top plate by following the instructions in this section. Section 4.I provides complete re-assembly instructions.

ALL MAINTENANCE AND OVERHAUL SHOULD BE PERFORMED FROM THE TOP. THE BOTTOM PLATE OF THE TONG IS TYPICALLY WELDED TO THE SIDE BODY AND CANNOT BE REMOVED.

REPLACEMENT FASTENERS (BOLTS, NUTS, CAP SCREWS, MACHINE SCREWS, ETC.) USED DURING MAINTENANCE OR OVERHAUL MUST BE GRADE 8 OR EQUIVALENT UNLESS OTHERWISE SPECIFIED.

REMOVAL OF BACKUP

1. Construct a support that will support the entire weight of the backup assembly.
2. Use a crane to hoist the tong and backup by the master link, and lower onto structure constructed in step 1 until the weight is completely removed from the front leg and rear support springs.
3. Free the front leg springs by removing the hitch pin securing the lower locking pins, and removing the locking pins. Remove the rear leg spring to give the tong and leg assembly adequate room to maneuver when lifting away from the backup.
4. Lift the tong, and front and rear legs, up and away from the backup. Use caution so that the springs and top spring washers, which will come loose from the front legs when the tong is lifted, are not lost.

REMOVAL OF LEG ASSEMBLIES

5. Set the tong and leg assembly onto a flat surface. Ensure that the majority of the weight remains supported by the rigid sling and the crane. Remove the four heavy hex bolts securing the rear leg assembly to the tong.
6. Remove the 1/2" x 3-1/2" bolts, narrow washers, and nylock nuts securing the front leg weldments to the leg mount weldments.
7. Lift the tong up and away from the legs - ensure that the front legs do not fall over when the tong is lifted away. Place the tong on a suitable surface that will support the entire weight of the tong and allow access to the bottom plate.

REMOVAL OF TOP PLATE

8. Continue to support the rigid sling with a crane. Remove the two hitch pins from each rigid sling pin, and remove the rid sling pins. The rigid sling may now be lifted away from the tong. Remove both rigid sling hanger bracket weldments.
9. Disconnect the hydraulic connections from the motor. Remove the bolts securing the safety door plunger block to the top plate near the door. Undo the restraints securing the inlet and outlet lines from their supports, and the four 3/8" x 1" bolts securing the valve mount weldment to the top plate. Lift the entire hydraulic valve section away from the tong. Remove the inlet and outlet support pieces.
10. Remove the adjustable outlet support from the top plate.
11. Remove the tong door cylinder.
12. Remove the door assembly by removing the door pin. Remove the 1" outside snap ring from the shaft just inside the top and bottom door weldment plate and slide the shaft out the bottom. Support the door assembly as the door pin is removed - a soft alloy material (e.g. brass rod, etc.) may be required to lightly tap the shaft through the door assembly until it comes free at the bottom.
13. Remove the two socket head cap screws securing the torque gauge mount to the motor mount, and lift the gauge mount out of place.
14. Remove the remaining two socket head cap screws securing the motor, and lift the motor off the motor mount. Inspect the motor gear, located at the bottom of the motor shaft, for gear clashing or tooth damage. Also, ensure that the motor gear is securely attached to the motor shaft.
15. Remove the motor mount by removing the four socket head cap screws. The motor mount can be lifted out of place. Take care not to lose the two position dowels - one, or both, may come off with the mount.
16. Remove the snap ring that secures the clutch drive gear. Remove the clutch drive gear and top clutch spacer. Remove the six #10 x 3/4" socket head cap screws securing the bearing retainer to the top plate, and slide the bearing and bearing retainer up and off the clutch shaft.
17. Remove the clevis pin connecting the shifting shaft handle to the shifting shaft. Back off the shifter position detent spring and ball assembly as much as possible without removing the adjustment bolt.
18. Remove the access panel on the body side adjacent to shifter assembly. Remove the 5/8" fine thread nut, and 5/8" fine thread jam nut from the shifting shaft to release the shifting fork from the shaft. The shifting shaft may now be carefully rotated and pulled out of the top shifter bushing. Use caution that the shifter detent ball is not dislodged and lost when the shifter shaft is removed.

Continued on next page...

4.H REMOVAL OF TOP PLATE FOR OVERHAUL (CONTINUED):

19. Remove the four 3/8" x 1" hex bolts and 3/8" lock washers securing the shifter lug weldment to the top plate, and remove the shifter lug and the shifter handle.
20. Remove the top brake band by removing the adjustment socket head cap screw and locking nut from the rear brake band lug, and the shoulder bolts from the front pivot points.
21. Remove the bottom brake band by removing the the adjustment socket head cap screw and locking nut from the rear brake band lug, and the shoulder bolts from the front pivot points.
22. If not already done, remove the jaw pivot bolts and the jaw assemblies.
23. Remove the backing pin assembly.

THE CAGE PLATE BOLTS ARE THE ONLY ITEMS FASTENING THE BOTTOM CAGE PLATE TO THE TONG. SUPPORT THE BOTTOM CAGE PLATE FROM BELOW PRIOR TO REMOVING CAGE PLATE BOLTS IN ORDER TO PREVENT DAMAGE TO THE BOTTOM CAGE PLATE OR PERSONAL INJURY TO THE MECHANIC

24. Remove the upper and lower nuts and washers from the front cage plate spacers, Remove the rear cage plate bolts, washers, and nuts, and the rear cage plate spacer. The cage plates may now be removed.
25. Pull the top bearing cap and spacer for the pinion drive gear by removing the four 1/2" bolts which secure the bearing cap to the top plate. Thread two of the removed bolts into the extra holes on top of the bearing cap, and use them as lifting lugs to lift the bearing cap out of place.

IF THE BEARING REMAINS ATTACHED TO THE GEAR SHAFT AFTER THE BEARING CAP IS PULLED, FARR SERVICE PERSONNEL RECOMMENDS LEAVING IT IN PLACE UNTIL THE TOP TONG PLATE IS REMOVED.

26. Remove the hex head bolts and recessed socket head cap screws around the perimeter of the tong which secure the top plate to the gear case housing.
27. With all the above steps taken, the top tong plate can be lifted off providing access to the inside of the gear case. Note that the top cam follower array remains attached to the top plate - these cam followers should all be inspected, and replaced if necessary.

4.I ASSEMBLY PROCEDURES

Although the assembly of McCoy hydraulic power tongs is straightforward, and can be accomplished without the use of special tools, the instructions in this subsection are presented as a guide only and are similar to the assembly sequence our technician would use while assembling the tong in our plant.

NOTE ON INSTALLATION PRACTICES: Ensure all bearings are liberally greased before installing over a shaft or into gears or bearing caps. When inserting a shaft through a support roller assembly ensure shaft is greased. Also ensure all metal-to-metal contact in the gear train is adequately greased. When graphics are not used in the assembly process, please refer to the relevant exploded diagrams in Section 6.

ALL FASTENERS USED DURING REASSEMBLY OF LOAD-BEARING COMPONENTS (CHAIN SLINGS, RIGID SLINGS, BACKUP LEGS) MUST BE TIGHTENED TO THE CORRECT TORQUE. THREADED FASTENERS USED IN LOAD-BEARING DEVICES MUST BE SECURED WITH RED LOCTITE™.

TIGHTENING TORQUE GUIDE			
SAE GRADE 8 - FINE THREAD			
SIZE	CLAMP LOAD	PLAIN	PLATED
¼ - 28 (.250)	3,263	14 ft. lbs.	10 ft. lbs.
5/16- 24 (.3125)	5,113	27 ft. lbs.	20 ft. lbs.
⅜ - 24 (.375)	7,875	49 ft. lbs.	37 ft. lbs.
7/16 - 20 (.4375)	10,650	78 ft. lbs.	58 ft. lbs.
½ - 20 (.500)	14,400	120 ft. lbs.	90 ft. lbs.
9/16 - 18 (.5625)	18,300	172 ft. lbs.	129 ft. lbs.
⅝ - 18 (.625)	23,025	240 ft. lbs.	180 ft. lbs.
¾ - 16 (.750)	33,600	420 ft. lbs.	315 ft. lbs.
⅞ - 14 (.875)	45,825	668 ft. lbs.	501 ft. lbs.
1 - 12 (1.000)	59,700	995 ft. lbs.	746 ft. lbs.
1 - 14 (1.000)	61,125	1019 ft. lbs.	764 ft. lbs.
1-⅛ - 12 (1.125)	77,025	1444 ft. lbs.	1083 ft. lbs.
1-¼ - 12 (1.125)	96,600	2012 ft. lbs.	1509 ft. lbs.
1-⅜ - 12 (1.375)	118,350	2712 ft. lbs.	2034 ft. lbs.
1-½ - 12 (1.500)	142,275	3557 ft. lbs.	2668 ft. lbs.
SAE GRADE 8 - COARSE THREAD			
SIZE	CLAMP LOAD	PLAIN	PLATED
¼ - 20 (.250)	2,850	12 ft. lbs.	9 ft. lbs.
5/16- 18 (.3125)	4,725	25 ft. lbs.	18 ft. lbs.
⅜ - 16 (.375)	6,975	44 ft. lbs.	33 ft. lbs.
7/16 - 14 (.4375)	9,600	70 ft. lbs.	52 ft. lbs.
½ - 13 (.500)	12,750	106 ft. lbs.	80 ft. lbs.
9/16 - 12 (.5625)	16,350	153 ft. lbs.	115 ft. lbs.
⅝ - 11 (.625)	20,325	212 ft. lbs.	159 ft. lbs.
¾ - 10 (.750)	30,075	376 ft. lbs.	282 ft. lbs.
⅞ - 9 (.875)	41,550	606 ft. lbs.	454 ft. lbs.
1 - 8 (1.000)	54,525	909 ft. lbs.	682 ft. lbs.
1-⅛ - 7 (1.125)	68,700	1288 ft. lbs.	966 ft. lbs.
1-¼ - 7 (1.125)	87,225	1817 ft. lbs.	1363 ft. lbs.
1-⅜ - 6 (1.375)	103,950	2382 ft. lbs.	1787 ft. lbs.
1-½ - 6 (1.500)	126,450	3161 ft. lbs.	2371 ft. lbs.

REPLACEMENT FASTENER (BOLTS, NUTS, CAP SCREWS, MACHINE SCREWS, ETC.) USED DURING MAINTENANCE OR OVERHAUL MUST BE GRADE 8 OR EQUIVALENT UNLESS OTHERWISE SPECIFIED.

4.I ASSEMBLY PROCEDURES (CONTINUED):

1. Position the tong body gear case weldment on a suitable stationary support such that the bottom body plate is accessible.
2. Install twenty cam followers (PN SSCF1500) onto the bottom plate as shown in the following illustration. Secure each cam follower with a ⅞" lock washer and ⅞" UNC hex nut.

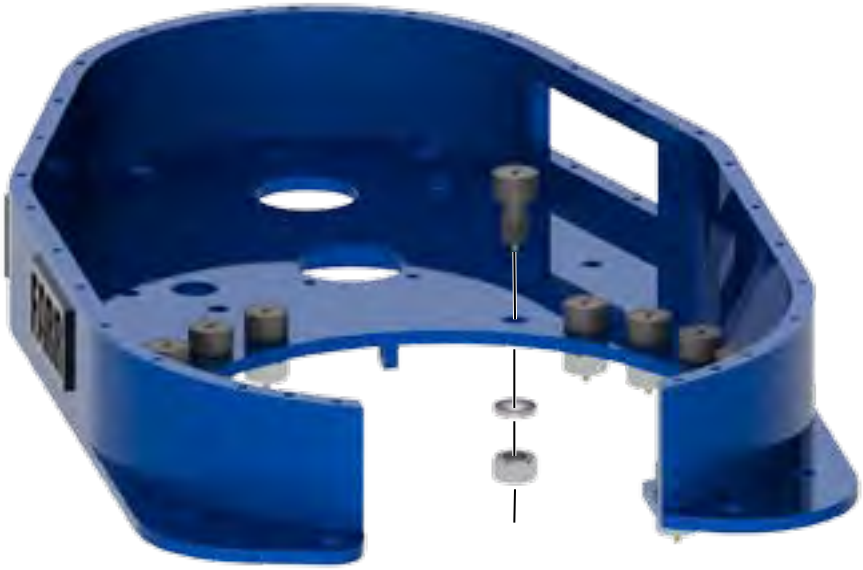


ILLUSTRATION 4.I.1: CAM FOLLOWER INSTALLATION - BOTTOM PLATE

3. Install rotary gear, ensuring the backing pin slots face up. The outside of the rotary gear rides on top of the cam followers installed in the step 2.
4. Press pinion bearing (PN 1234-08-01B) into bottom pinion bearing cap (PN AK01-151), and install bearing cap into bottom plate of tong using four ½" UNC x 1-¼" hex bolts and ½" lock washers.
5. Press lower clutch bearing (PN 02-0076) into clutch bearing cap (PN AK01-201), and install bearing cap into bottom plate of tong using four ⅜" UNC x 1-¼" hex bolts and ⅜" lock washers.
6. Press two idler bearings (PN 02-E0104) into each rotary idler gear (PN AK01-102). Ensure the bearings are pressed tight to the inner flange on the idler gears. Insert a bearing retainer ring (PN 02-E105) into each idler gear to secure the bearings.
7. Lightly grease each rotary idler shaft (PN 101-5005) and insert into the gear and bearing assemblies. For reference, if the rotary idler shaft is inserted through the gear and bearing assembly correctly the snap ring in the gear assembly will be oriented toward the bottom of the idler shaft. The bottom of the shaft in not drilled and tapped for a grease fitting. Centre the gear and bearing assembly on each rotary idler shaft (See illustration 4.I.2 next page).

4.I ASSEMBLY PROCEDURES (CONTINUED):

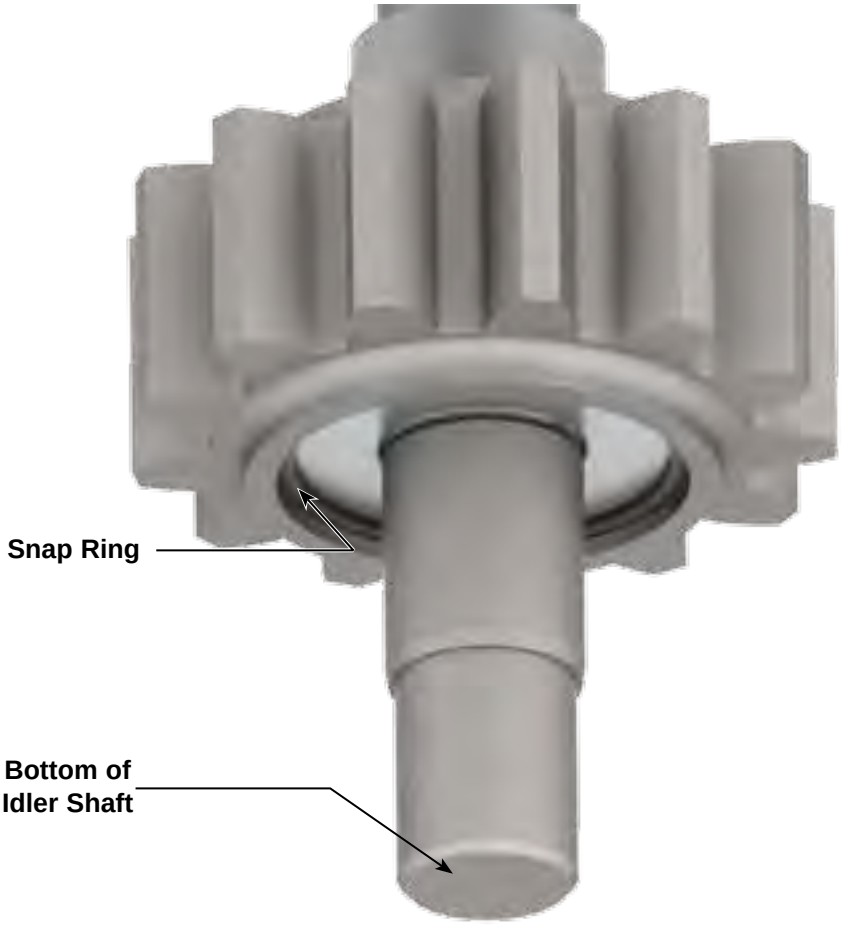


ILLUSTRATION 4.I.2: ROTARY IDLER GEAR ORIENTATION

8. Slide a rotary idler spacer over each end of the rotary idler
9. Install each rotary idler assembly, ensuring bottom of the shafts are inserted through the bottom plate.
10. Slide the high pinion gear (PN 997-A4-87B) over the end of the pinion gear shaft (PN 997-A7-86B). Ensure the pinion gear is oriented correctly when installing the high pinion gear - see Pg. 6.12 for an exploded view. Place the end of the pinion shaft with the high pinion gear into the lower pinion bearing installed in Step 4.
11. Install one retainer clip (PN 02-0009) into each pinion idler gear (PN AK01-122). Lightly grease the inside of the gears, and press a rotary idler bearing (PN 02-0075) into each gear, tight to the previously installed retainer. Secure each bearing with another retainer clip (PN 02-0009).
12. Insert each pinion idler half-shaft through the pinion idler gear assemblies. Place a bearing seal (PN 02-0010) over the end of each pinion idler shaft, and secure shafts and seals to the gear assemblies using a small retainer ring (PN 02-0008).
13. Place the ends of each pinion idler through the bottom plate, ensuring the pinion idler gears mesh smoothly with the rotary idler gears and the pinion gear shaft.

4.I ASSEMBLY PROCEDURES (CONTINUED):

14. Place the tong body stiffener plate (PN AK00-001) onto the bottom of the tong, and secure the stiffener plate in place with the ½" UNC x 2-½" hex bolts,½" lock washers, and 1-½" UNF nylock nuts used to secure the pinion idler half-shafts to the bottom plate. Secure the rear of the stiffener plate with a ½" UNC x 1-¼" hex bolt and ½" lock washer, next to the clutch bearing cap.

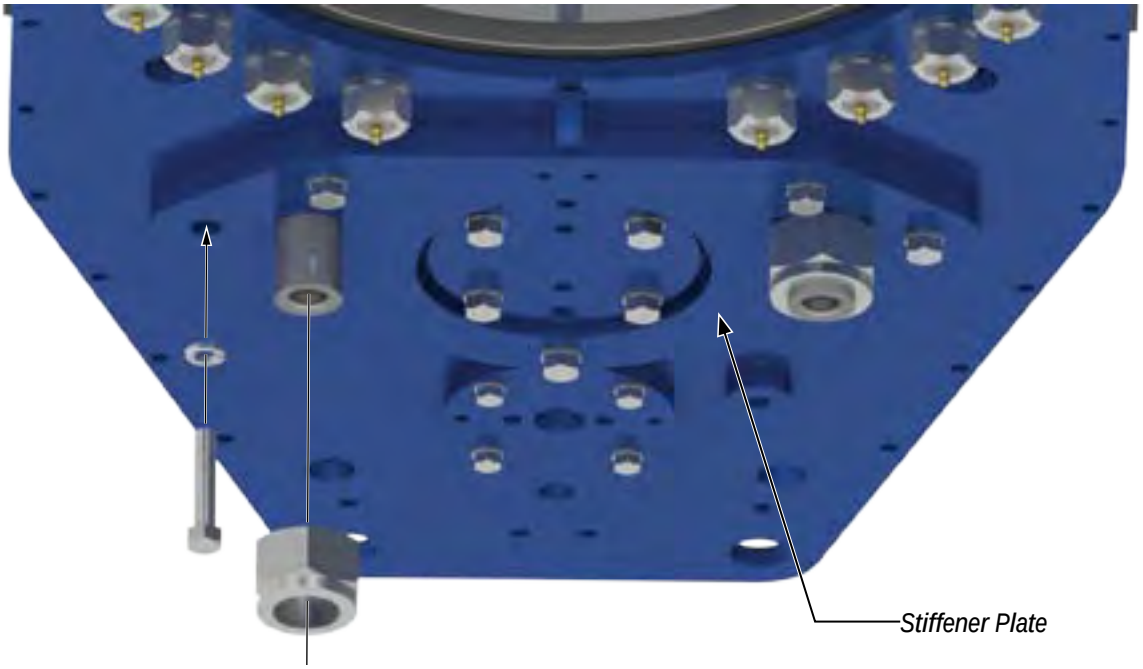


ILLUSTRATION 4.I.3: STIFFENER PLATE INSTALLATION

15. Lightly grease clutch o-ring (PN 08-1240) and insert into the o-ring groove in the clutch bearing cap.

ILLUSTRATION 4.I.4: CLUTCH O-RING INSTALLATION

16. Lightly grease all four needle bearings (PN 02-1404), and slide two bearings over each end of the clutch shaft and press tight to the center gear in the clutch shaft.
17. Slide the high clutch gear (PN 997-HT-51B) over the bottom end of the clutch shaft (the bottom end of the clutch shaft can be identified by the threaded ⅛" NPT port for a grease fitting) and press on to the two needle bearings on that side of the center gear on the clutch shaft. Ensure the gear is properly oriented on the shaft - the smaller diameter portion of the gear must be oriented toward the center clutch shaft gear.

4.I ASSEMBLY PROCEDURES (CONTINUED):

18. Slide the lower clutch spacer (PN 997-99) over the bottom end of the clutch shaft - the side of the spacer with the small shoulder should be oriented toward the lower clutch bearing and the flat side against the high clutch gear.
19. Insert the bottom end of the clutch shaft into the clutch bearing cap, ensuring that the o-ring does not become dislodged - the o-ring should slide over the outside circumference of the clutch shaft. Mesh the high clutch gear with the high pinion gear.
20. Slide the shifting collar (PN 997-HT-62) over the top of the clutch shaft and mesh with the center clutch shaft gear.
21. Slide the low clutch gear (PN 997-HT-52) over the top of the clutch shaft and press onto the remaining two needle bearings - press tight to clutch shaft shaft center gear.
22. Slide clutch gear spacer (PN AK01-204) over the top of the clutch shaft and press tight to the low clutch gear.
23. Slide the low pinion gear (PN 997-A5-88) on to the pinion gear shaft, ensuring that the smaller diameter shoulder on the low pinion gear is facing up.
24. Insert two positioning dowel pins (PN 09-0092) into the two un-threaded holes in the side body weldment on either side of the door opening.
25. Install door latch post (PN 101-5108) into the machined hole in the front of the bottom plate next to the opening (see illustration 4.I.5).

ILLUSTRATION 4.I.5: DOOR LATCH POST INSTALLATION

4.I ASSEMBLY PROCEDURES (CONTINUED):

26. Install twenty cam followers (PN SSCF1500) onto the top plate as shown in the following illustration. Secure each cam follower with a ⅞" lock washer and ⅞" UNC hex nut.

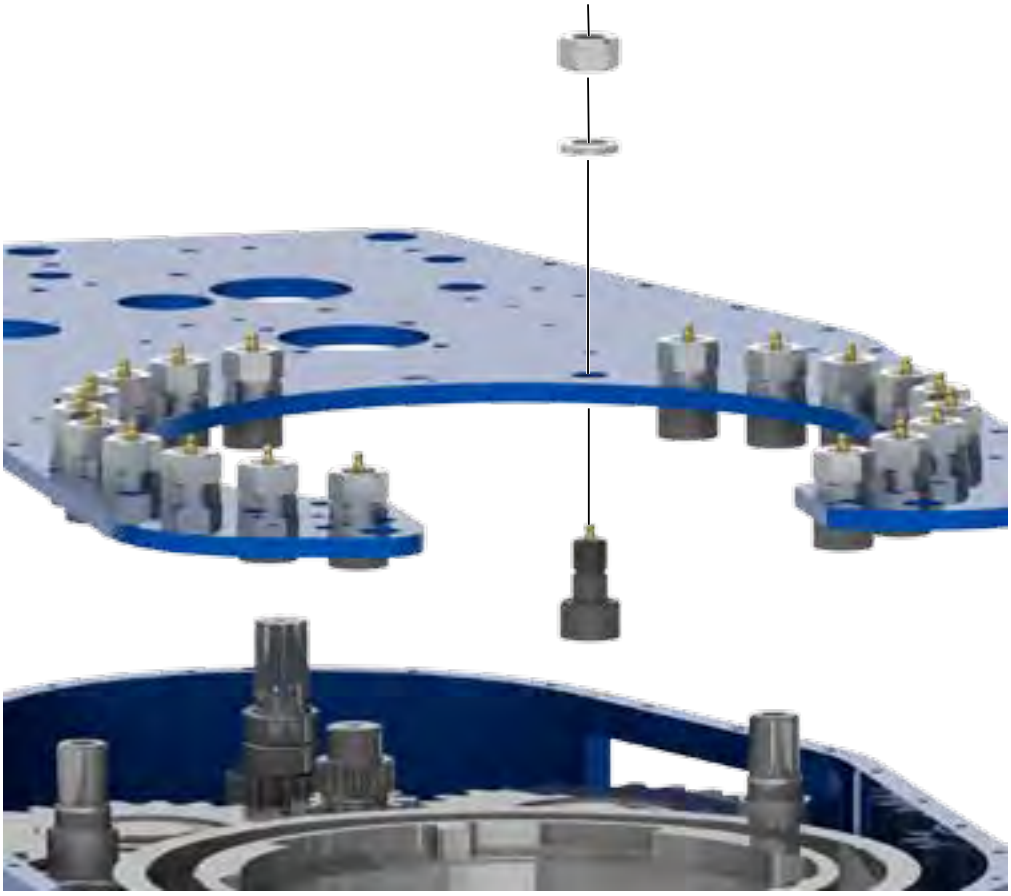


ILLUSTRATION 4.I.6: CAM FOLLOWER INSTALLATION - TOP PLATE

27. Install top plate onto side body assembly. Secure plate with ⅜" UNC x 1-½" hex bolts and ⅜" lock washers, and ⅜" UNC x 1-¼" hex socket head cap screws. Do not install fasteners in the rigid sling bracket or hydraulic support locations as shown in Figure 4.I.7.

ILLUSTRATION 4.I.7: TOP PLATE FASTENERS

4.I ASSEMBLY PROCEDURES (CONTINUED):

28. Press top clutch bearing (PN 02-0077) into the top clutch bearing retainer (PN AK01-203), and install top clutch bearing/bearing retainer on to the top plate using six 10-24 x ¾" hex socket head cap screws.
29. Slide the bearing spacer (PN AK01-205) over the end of the clutch shaft.
30. Install clutch drive gear (PN 997-HT-61) on to the end of the clutch shaft, ensuring the "cut out" on the drive gear faces up. Secure with an external snap ring (PN 1234-00-04).
31. Press the remaining pinion bearing (PN 1234-08-01B) into the top pinion bearing cap (PN 997-D15-89), and install on to the top plate of the tong over the pinion shaft, ensuring that the pinion bearing spacer (PN 1400-89A) is placed between the bearing cap and the top plate. Secure with four ½" UNC x 1-¼" hex bolts and ½" lock washers.
32. If not already done thread three ⅝" UNC hex socket set screws into the top shifter bushing (PN 101-0020). Thread the top shifter bushing into the top plate, ensuring the unplugged hole in the bushing faces toward the left rear of the tong at roughly a 45° angle. Thread the shifter detent tube (PN 101-0019) into the shifter bushing.

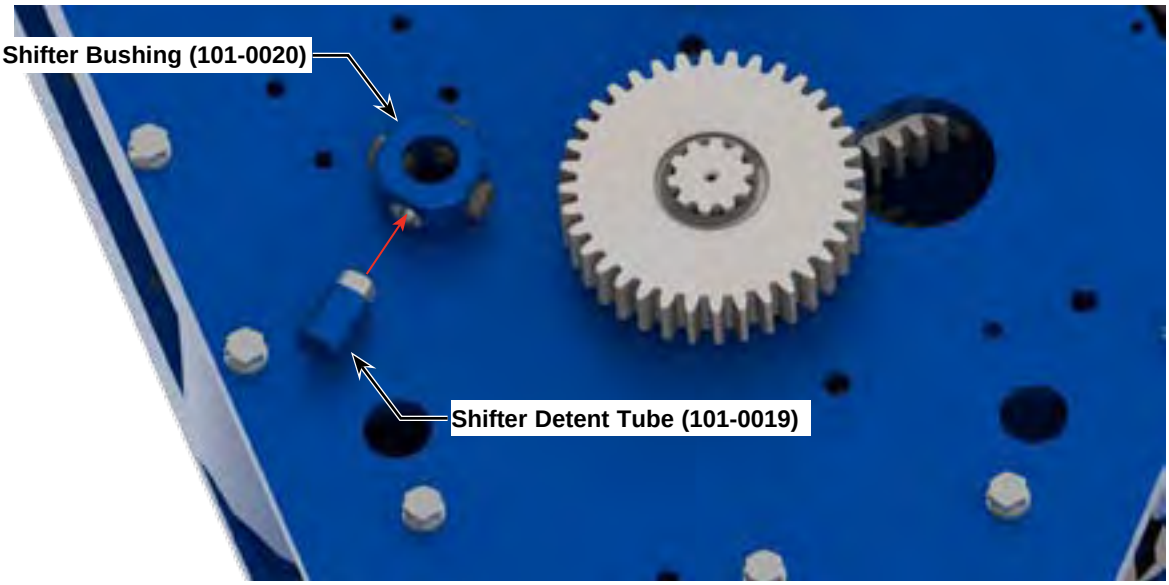


ILLUSTRATION 4.I.8: TOP SHIFTER BUSHING INSTALLATION

33. Position the shifting fork (PN 997-HT-72) in its proper position, engaged with the shifting collar. Lightly grease the shifting shaft (PN 1400-71) and insert through the top shifter bushing, which is typically welded to the top plate. Continue to insert the shaft through the shifting fork, and secure the fork with three ¼" UNC x ⅜" hex socket head set screws. See Pg. 6.19 for set screw installation.
34. Insert the shifter detent ball (PN 02-0018) into the detent tube on the top shifter bushing. Insert the shifter detent spring (PN 997-0-64) into the detent tube. Thread a 7/16" UNF jam nut on to the 7/16" UNF x 1-¼" hex bolt, and then thread the bolt into the end of the detent tube. Lock the bolt to the detent tube with the hex nut. See Pg. 4.10 for shifter detent tension adjustment instructions.
35. Place two 5/16" motor mount positioning dowel pins (PN 09-0170) in to their locations in the un-threaded holes adjacent to the the clutch drive gear. Install the motor mount (PN-C8-150) on to the top plate and secure with four ½" UNC x 2" hex socket head cap screws.
36. Install 5/16" x 5/16" x 2" square key into the key slot on hydraulic motor shaft. Install motor gear (PN 997-A10-149) on to the hydraulic motor shaft over the key, and secure with two ⅜" UNC x ⅜" flat point hex socket set screws.
37. Install motor on to motor mount. Secure the RH side of the motor (as seen from the back of the tong) with two ½" UNC x 1-½" hex socket head cap screws and ½" lock washers. The torque gauge holder weldment (PN 1500-09-04A) is secured by the two LH motor screws - position the torque gauge holder weldment in place, and secure it and the LH side of the motor with two ½" UNC x 1-¼" hex socket head cap screws and ½" lock washers.

4.I ASSEMBLY PROCEDURES (CONTINUED):

38. Install twenty cam followers (PN 02-0016) into the bottom cage plate weldment (PN AK20-20W-KT), and secure the cam followers with ⅝" UNF thin nylock nuts. Install 20 cam followers into the top cage plate (PN AK20-10W-KT). Assemble the top and bottom cage plates around the body plates and rotary gear using two rear cage plate tubular spacers (101-4992), two threaded front cage plate spacers (PN AK20-031), two ½" UNC x 6-¼" bolts, two ½" narrow flat washers, two ½" UNC thin nylock nuts, four 5/16" UNC hex nuts, and four 5/16" lock washers.

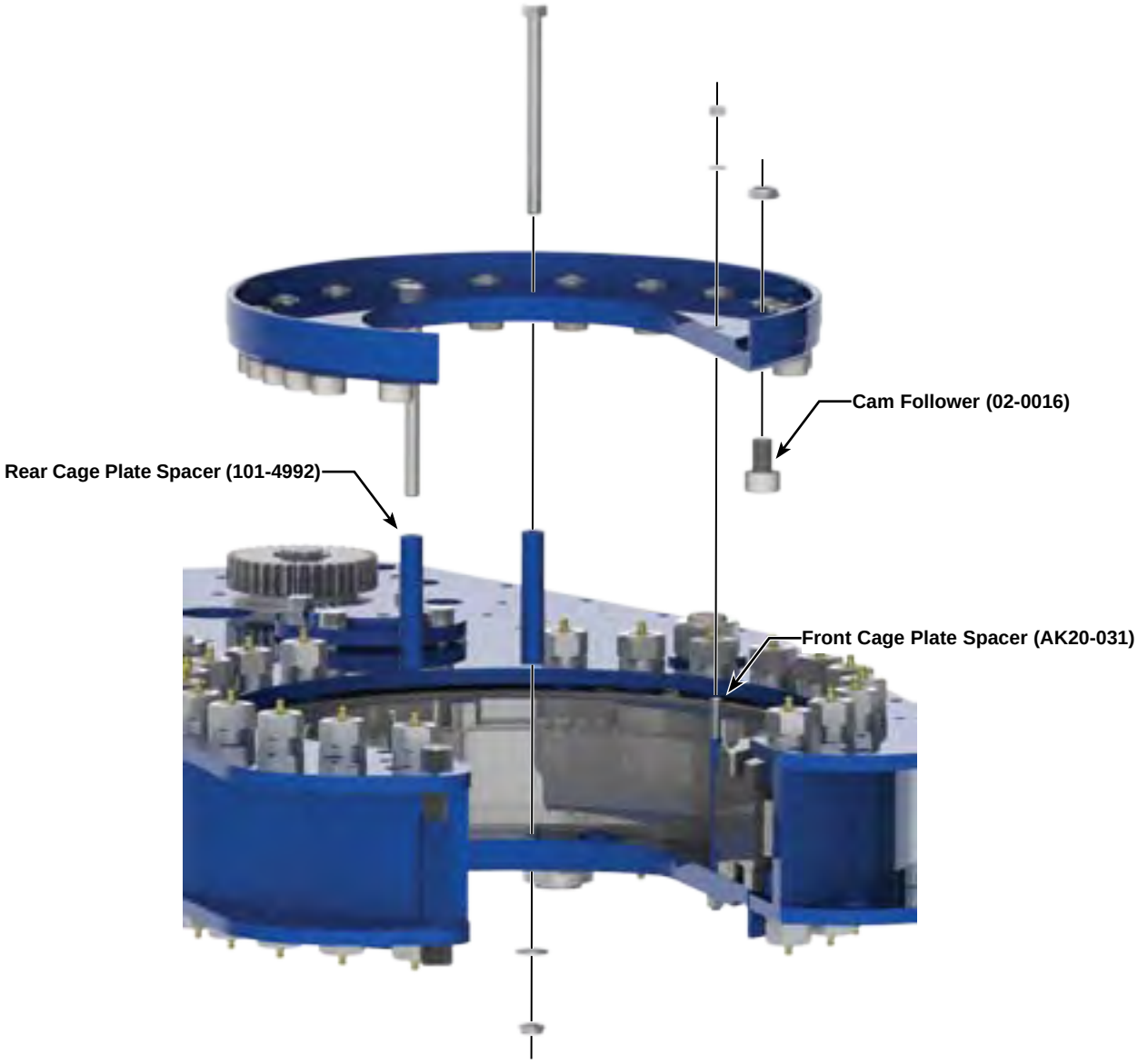


ILLUSTRATION 4.I.9: CAGE PLATE ASSEMBLY

39. If not already done, thread 1-¼" UNF nylock nuts on to each end of the rotary idler shafts.
40. If not already done, thread 1-½" UNF nylock nuts on to the ends of the pinion idler shafts.
41. Attach the shifter lug weldment (PN 101-0016) to the top plate of the tong next to the top shifter bushing weldment using four ⅜" UNC x 1" hex bolts and ⅜" lock washers.
42. Connect the shifter handle weldment's (PN AK00-092) pivot point to the pivot point of the shifter lug weldment using a 5/16" x 1-1/2" clevis pin. Connect the end of the shifter handle weldment to the top of the shifter shaft using a 5/16" x 1" clevis pin. Secure the clevis pins with .093" X 1.125" hitch pins.
43. Slide the backing pin retainer (PN 101-4040) over the backing pin spacer tube (PN 101-4995). Mount the spacer tube to the top cage plate using a ½" UNC x 4-½" hex bolt, ½" narrow flat washer, and a ½" UNC thin nylock nut.

4.I ASSEMBLY PROCEDURES (CONTINUED):

44. Ensure a ⅜" threaded stud (PN 101-4058) has been threaded into the backing pin (PN 101-4994). Insert the backing pin/threaded rod assembly through the backing pin retainer, and secure with the backing pin knob (see Pp 6.20 for a detailed exploded view).
45. Install upper and lower lined brake band weldments (PN 101-4999). Secure the rear of the top brake band to the brake band retainer studs on the top and bottom plates with a ½" UNC x 3-¾" hex socket head cap screw and 1/2" UNC thin nylock nut each, and secure the front of the weldments to the top and bottom plates with ½" x 1-½" hex socket shoulder screws.
46. Assemble the door latch (see Pg. 6.30 for an exploded view):
    i. Insert the door latch shaft (PN 101-5249) through the bottom door plate until it is about halfway to the top door plate.
    ii. Slide a door latch bushing (PN 02-E124) shoulder-down over the shaft until it is tight to the shoulder on the pivot shaft.
    iii. Slide the door latch on to the bushing installed in the last step. ASSEMBLY NOTE: Ensure the latch is oriented toward the latch post installed in Step 25.
    iv. Slide a second door latch bushing over the shaft, shoulder-down,
    v. Install the latch handle weldment on to the second latch bushing, with the handle part of the weldment pointing toward the bottom plate of the door weldment.
    vi. Slide a thrust washer (PN 02-E0125) over the top of the latch shaft..
    vii. Slide the end of the latch shaft through the top door plate and secure with a ⅝" UNC nylock nut and ⅝" narrow flat washer.
    vi. Insert the door latch spring (PN 997-13D) into the round receptacle in the door weldment (PN AK12-702B-KT-SINGLE).

ASSEMBLY NOTE: See Illustration 4.I.10 for a view of the assembled latch.

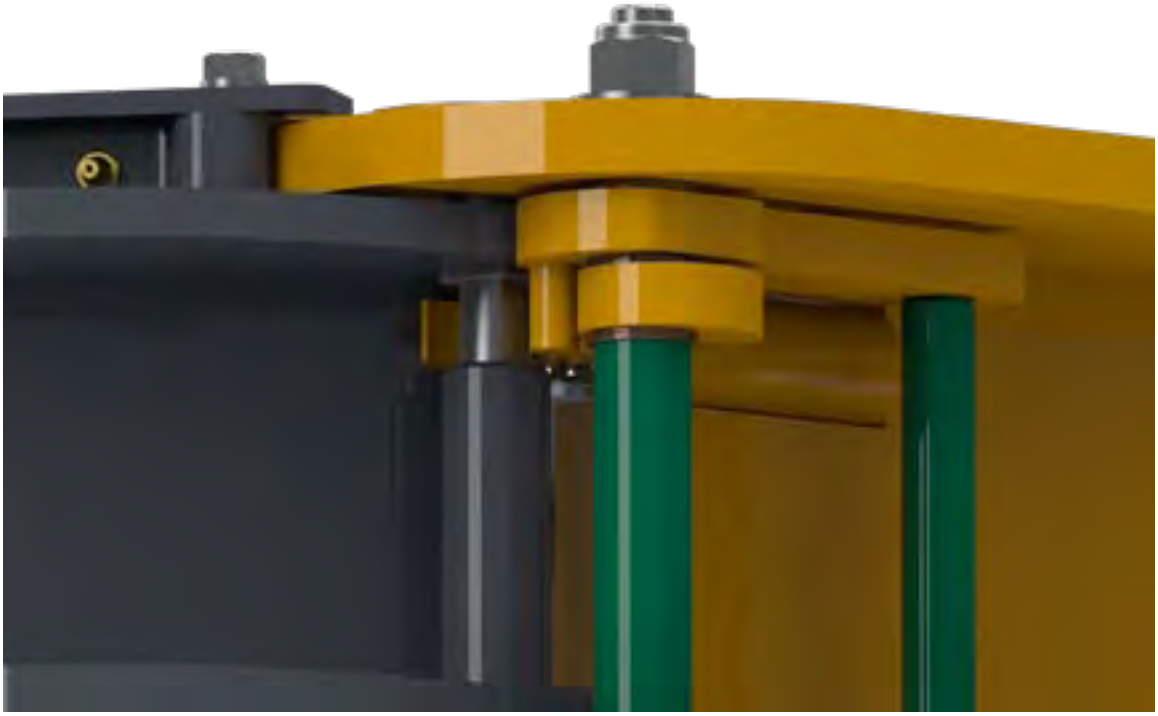


ILLUSTRATION 4.I.10: TONG DOOR LATCH (ASSEMBLED)

47. Insert door bushings (PN 02-E0126) in to the top and bottom plates of the door weldment (PN AK12-702B-KT-SINGLE).
48. Position the door weldment over the top and bottom plates so the post holes in the door weldment align with the post holes in the body plates. Insert the door pivot shaft (PN 101-5034) from the top through the body plates and door weldment. Secure the shaft with a ¾" UNC thin nylock nut and a ¾" narrow flat washer. **ASSEMBLY NOTE:** Ensure a 1" regular flat washer is inserted between the bottom of the top door plate and the top of the top body plate, and the top of the bottom door plate and the bottom of the bottom plate.
49. Install the door cylinder (PN 101-0069) onto the lugs on the door weldment and body (typically welded to the top plates). Secure the rear of the cylinder with a ½" x 2" UNC hex socket head shoulder bolt, and the front of the cylinder with a ½" x 1" UNC hex socket head shoulder bolt.
50. Install the RH rigid sling bracket (PN 101-1244) and the LH rigid sling bracket (PN 101-1245). Secure each bracket to the top plate with two ⅜" x 2" hex bolts and lock-washers.

4.I ASSEMBLY PROCEDURES (CONTINUED):

51. Use a crane to position the rigid sling weldment, and connect to the two rigid sling brackets using one rigid sling pin (PN AK00-056) per side. Secure each rigid sling pin with two 0.243" x 5.125" hitch pins.
52. Pre-mount the main hydraulic inlet line to the inlet section on the valve bank. Mount the main valve bank to the valve mount weldment (PN AK00-070B-KT) using four ½" UNC x 4-½" hex bolts, two ½" narrow flat washers per bolt, and four ½" UNC nylock nuts. Secure the hydraulic line to the top of the valve mount weldment using a 3/8" UNC threaded U-bolt (PN 101-2075) and two ⅜" UNC nylock nuts.
53. Install the valve mount weldment on the top plate, directly over the top pinion bearing cap. Secure with four ⅜" UNC x 1" hex bolts and ⅜" lock washers.
54. Attach the inlet coupling support weldment (PN 101-1138) to the top plate directly behind the RH rigid sling bracket. Secure with two ⅜" UNC x 1" hex bolts and ⅜" lock washers. Attach the adjustment plate (PN 101-5075) to the support weldment using four ⅜" UNC x 1" hex bolts, two ⅜" narrow flat washers per bolt, and four ⅜" UNC nylock nuts.
55. Attach the two #20 (1-¼") x JIC 1" flange elbows (PN 02-9216) to the motor ports using two #20 split flange kits (PN 02-9217).
56. Attach the valve mount handle weldment (PN AK00-076) to the top LH side of the valve mount weldment (as seen from the rear of the tong) using two 5/16" UNC x 1" hex bolts, two 5/16" narrow flat washers per bolt, and two 5/16" UNC nylock nuts.
57. Install the safety door cam (PN 101-5598) on to the top door plate over the shoulder bushing using three ⅜" UNC x 2" hex bolts and ⅜" lock washers.
58. Install the safety door valve mounting plate (PN 101-5592) to the top plate of the tong adjacent to the safety door cam using three ⅜" UNC x ¾" hex bolts and ⅜" lock washers.
59. Attach the safety door hydraulic switch (PN 02-E0190) to the safety door valve mount / protector weldment using four ¼" UNC x 2" hex bolts and four ¼" lock washers.
60. Attach the safety door valve mount / protector weldment to the safety door valve mounting plate using three ⅜" UNC x 1" hex bolts and ⅜" lock washers.
61. Install grease fittings as follows:
    i. Install a ¼" UNF straight thread grease fitting (PN 02-0097) in the end of each rotary idler shaft, located on the top side of the tong.
    ii. Install a ⅛" NPT grease fitting (PN 02-0005) in the end of each pinion idler half-shaft, located on the bottom side of the tong.
    iii. Install two ⅛" NPT 90° grease fittings (PN 02-0093) in each pinion bearing cap
    iv. Install two ⅛" NPT 90° grease fittings (PN 02-0093) in the clutch bearing cap on either side of the center hole, and one ⅛" NPT grease fitting (PN 02-0005) in the end of the clutch shaft, accessed through the center hole in the clutch bearing cap.
    v. Install a ⅛" NPT 90° grease fitting (PN 02-0093) in the threaded port on top of the motor mount.

ALL CAM FOLLOWERS ARE OEM-EQUIPPED WITH GREASE FITTINGS

62. Set the rear leg weldment (PN 101-5098) on a flat concrete surface, in a clear area as close to the tong assembly as possible. Use a crane to hoist the tong using the master link, and lower it on to the rear leg weldment, ensuring most of the weight remains supported by the crane.
63. Secure the tong to the rear leg using two 1-¼" UNC x 8" modified heavy hex bolts (PN 101-0040) and two 1-¼" UNC heavy hex nuts in the two rear-most locations, and two 1" UNC x 7" heavy hex bolts and two 1" UNC nylock jam nuts in the two remaining locations.
64. Install the rear leg spring mount (PN AK06-550) in the rear leg weldment using two ½" UNC x 9" hex bolts, ½" narrow flat washers, and ½" UNC nylock nuts. Mount in the lowest location - the height may be adjusted later to suit your application.
65. Attach the RH front leg weldment (PN 101-5096) to the bottom plate of the tong using two ⅜" UNC x 1" hex bolts and ⅜" lock washers, and one ⅜" UNC x 2" hex bolts and ⅜" lock washer.
66. Attach the LH front leg weldment (PN 101-5100) to the bottom plate of the tong using two ⅜" UNC x 1" hex bolts and ⅜" lock washers, and one ⅜" UNC x 2" hex bolts and one ⅜" lock washer.
67. Support the backup on a structure that will support its complete weight, at least 36 inches (91 cm) off the floor.
68. Use a crane to hoist the tong and rear leg assembly and place in position over the backup. Guide the rear leg so that the "paddle" on the backup sits between the vertical plates of the rear leg when the tong and rear leg assembly is in position over the backup.

4.I ASSEMBLY PROCEDURES (CONTINUED):

69. Install the rear leg spring (AK06-502) between the rear leg spring mount and the backup body weldment. Use two spring clamps (PN AK06-504) and two ⅜" UNC x 1-¼" hex bolts and ⅜" lock washers per clamp to secure the rear leg spring to the rear leg spring mount.

ILLUSTRATION 4.I.11: REAR LEG SPRING INSTALLATION

70. Insert a front leg tube weldment (PN 101-2360) from the bottom of the backup, through the backup body, and in to the leg mount weldment on the tong. Secure the leg tube with a 7/16" UNC x 4" hex bolt, 7/16" narrow flat washer, and a 7/16" UNC nylock nut. Repeat for the other leg tube.
71. Slide a top spring cap (PN AK06-603) over each front leg tube weldment from the bottom, followed by a leg spring (PN AK06-606) and a bottom spring cap (PN AK06-604). Secure each leg spring and bottom spring cap to the leg tube using a hitch pin (PN 09-0268).
72. Lift the tong and backup assembly away from any supporting structures and place flat on a sturdy surface.

4.J DAILY INSPECTION & MAINTENANCE CHECKLIST (POWER TONG)

Farr recommends that the following inspection and maintenance procedures be performed before each use, and at least once per day when the tong is in steady use, in the order in which they are listed.

1. ☐ Rotate cage plate/rotary gear until the opening in the rotary gear faces towards the rear of the tong.

DO NOT PERFORM ANY FURTHER ACTIONS OR MAINTENANCE WHILE THE TONG IS CONNECTED TO ANY HYDRAULIC POWER SUPPLY. FARR RECOMMENDS THAT ALL HYDRAULIC LINES ARE FULLY DISCONNECTED, AND RESIDUAL HYDRAULIC PRESSURE IS BLED OFF. ENSURE ADEQUATE CONTAINMENT IS IN PLACE TO PREVENT ENVIRONMENTAL CONTAMINATION FROM RESIDUAL HYDRAULIC FLUID.

DEPRESSURIZE HYDRAULIC SYSTEM IN PREPARATION FOR MAINTENANCE:

2. ☐
   1) Rotate the tong to the "open throat" position. Ensure tong and backup doors (if equipped) are closed. Fully extend the lift cylinder
   2) De-energize the power unit.
   3) Repeatedly actuate the tong motor control valve lever IN BOTH DIRECTIONS to dissipate any residual pressure in the valve and motor.
   4) Remove the hydraulic SUPPLY line from the equipment.
   5) Repeatedly actuate the remaining control valve levers IN BOTH DIRECTIONS to dissipate any residual pressure in the remainder of the hydraulic control system.
   7) Disconnect the hydraulic RETURN line from the equipment.
   8) Disconnect remaining hoses such as case drains, or lines connected to the turns counter.

HYDRAULIC PRESSURES AS HIGH AS OPERATING PRESSURE MAY REMAIN TRAPPED IN SMALL AREAS OF THE EQUIPMENT. ENSURE ALL MAINTENANCE IS CARRIED OUT BY A QUALIFIED SERVICE TECHNICIAN, AND THAT ADEQUATE PERSONAL PROTECTIVE EQUIPMENT IS USED TO GUARD AGAINST PRESSURE INJURIES

3. ☐ Perform an initial wash of the tong in order to remove the majority of dirt and grease build-up. Ensure adequate containment is in place to prevent environmental contamination from residual hydraulic fluid and dirty grease.
4. ☐ Remove the access panel on the side of the tong directly adjacent to the shifter mechanism.
5. ☐ Use a flashlight to perform a visual inspection of the gear train through the access panel and the opening of the rotary gear. If gear damage or chips of metal are seen, the tong should be removed from service and overhauled to avoid further damage. Replace access panel when inspection is complete.
6. ☐ Perform a visual inspection of all fasteners and protruding body pieces (example: hydraulic valve mounts, inlet & outlet line supports, tong legs, shifter handle pivot lugs). Tighten or replace loose or missing fasteners. Farr recommends that damaged or missing body parts be repaired or replaced as soon as possible.
7. ☐ Inspect the jaws and dies. Inspect the jaw roller pins for signs of damage - replace pins if necessary. If the pins are welded in place, replace the entire jaw assembly. Ensure dies are secure in the jaw - replace worn dies if necessary. Ensure that the jaw rollers rotate freely. Check to ensure the size of the loaded jaws match the size of casing or pipe you are running.
8. ☐ Perform a visual inspection of all lifting points - if visible damage is seen, including cracks, broken lugs, distorted metal, etc. replace damaged part(s) before placing tong in service. Also inspect all chains, master links, and turnbuckles - again, if any damage is noted replace the damaged part(s) before placing the tong in service.
9. ☐ Inspect tong for signs of premature wear, or moving parts that are rubbing (bare metal where there used to be paint is a good indication of wear.
10. ☐ Inspect backing pin(s). If cracked, broken, or bent it (they) must be replaced.
11. ☐ Inspect top and bottom brake band linings - replace if necessary. Unequal wear of the brake bands indicates that the brake band tension is not evenly adjusted. Refer to the maintenance section of the manual for instructions on properly adjusting brake bands.
12. ☐ Perform a visual inspection of all hydraulic lines. Replace flexible lines if they appear to be cracked, fatigued, or have visible signs of wear from contact with a rigid object.

13. ☐ Perform a visual inspection of all hydraulic lines. Replace flexible lines if they appear to be cracked, fatigued, or have visible signs of wear from contact with a rigid object.

14. ☐ Perform a complete greasing of the tong - refer to Maintenance section of the technical manual

15. ☐ Ensure main supply and return connections to the tong are fully made up. Re-connect the remainder of the hydraulic lines, and, if applicable, the electrical line to the turns counter.

FAILURE TO ENSURE THAT THE SELF-SEALING SUPPLY AND RETURN LINES ARE FULLY MADE UP MAY RESULT IN CATASTROPHIC EQUIPMENT FAILURE.

If using a stand-alone power unit, start it now - refer to the power unit technical manual for startup procedures. Listen to power unit for a moment to see if there are any unusual mechanical sounds (rubbing, grinding, excessive pump noise). If using a diesel unit, allow sufficient time for the engine to reach operating temperature before increasing engine RPM. Once engine is warm, gradually increase engine RPM until operating speed is reached.

16. ☐ Ensure that supply pressure is at or above the tong's specified operating pressure, and that the return pressure is less than 350 psi.

17. ☐ Perform a visual inspection of pressurized hydraulic lines. Document and correct any hydraulic fluid leaks.

18. ☐ Perform a full functional test of the tong. Report and correct any hydraulic leaks from the hydraulic valve bank, or from any hydraulic cylinders that are used.

19. ☐ Perform a visual inspection of the load cell. If using a tension load cell, replace any cracked, broken, or distorted components including links and chains. If using a compression load cell, replace any component that has been crushed or otherwise distorted through compression.

20. ☐ If applicable, inspect the load cell anchor pins (tension load cell only). Replace the anchor pins if cracking or metal distortion is seen.

21. ☐ If applicable, the weld securing the single load cell anchor to the bridge bar main plate must be inspected (compression load cell only). If the integrity of the weld has been compromised, the tong must be removed from service until the weld is repaired. The load cell beam will need to be disconnected and removed so the weld is visible. Before re-installing the beam, liberally grease the anchor pin before reinserting into the load cell beam.

22. ☐ Test safety door feature (if equipped). Open the tong door(s), and attempt to rotate the cage plate at low speed (low gear) in both directions (makeup and breakout). If cage plate begins rotating, the safety door mechanism is not functional, and the tong must be removed from service until the safety door mechanism can be repaired. If the safety door is operating correctly, cage plate rotation will not be inhibited once the door is closed and latched.

NEVER OPERATE YOUR EQUIPMENT WITH A BYPASSED OR MALFUNCTIONING SAFETY DOOR

23. ☐ While rotating the cage plate, ensure that the jaws properly cam. If the jaws do not cam properly, the brake bands need to be tightened. Incrementally adjust both the top and bottom brake bands EQUALLY until proper cam action is achieved.

4.K MONTHLY MAINTENANCE CHECKLIST - POWER TONG

The following maintenance checklist is intended as a guideline rather than a definitive maintenance schedule. Your equipment may require more, or less, maintenance depending upon the frequency of use, the percentage of maximum torque that your equipment is routinely subjected to, and the field conditions under which your equipment operates. Farr recommends that the following inspection and maintenance procedures be performed monthly, or in conjunction with your maintenance foreman's experience and best estimate of when your equipment is due for this maintenance.

1. ☐ Rotate cage plate/rotary gear until the opening in the rotary gear faces towards the rear of the tong.

DO NOT PERFORM ANY FURTHER ACTIONS OR MAINTENANCE WHILE THE TONG IS CONNECTED TO ANY HYDRAULIC POWER SUPPLY. FARR RECOMMENDS THAT ALL HYDRAULIC LINES ARE FULLY DISCONNECTED, AND RESIDUAL HYDRAULIC PRESSURE IS BLED OFF. ENSURE ADEQUATE CONTAINMENT IS IN PLACE TO PREVENT ENVIRONMENTAL CONTAMINATION FROM RESIDUAL HYDRAULIC FLUID.

DEPRESSURIZE HYDRAULIC SYSTEM IN PREPARATION FOR MAINTENANCE:

2. ☐
   1) Rotate the tong to the "open throat" position. Ensure tong and backup doors (if equipped) are closed. Fully extend the lift cylinder
   2) De-energize the power unit.
   3) Repeatedly actuate the tong motor control valve lever IN BOTH DIRECTIONS to dissipate any residual pressure in the valve and motor.
   4) Remove the hydraulic SUPPLY line from the equipment.
   5) Repeatedly actuate the remaining control valve levers IN BOTH DIRECTIONS to dissipate any residual pressure in the remainder of the hydraulic control system.
   7) Disconnect the hydraulic RETURN line from the equipment.
   8) Disconnect remaining hoses such as case drains, or lines connected to the turns counter.

HYDRAULIC PRESSURES AS HIGH AS OPERATING PRESSURE MAY REMAIN TRAPPED IN SMALL AREAS OF THE EQUIPMENT. ENSURE ALL MAINTENANCE IS CARRIED OUT BY A QUALIFIED SERVICE TECHNICIAN, AND THAT ADEQUATE PERSONAL PROTECTIVE EQUIPMENT IS USED TO GUARD AGAINST PRESSURE INJURIES

3. ☐ Clean the exterior of the tool thoroughly, using either water (if using a pressure washer ensure a low-pressure wash wand is used), or an appropriate solvent-based grease-cutting cleaner such as Varsol. Ensure adequate containment is in place to prevent environmental contamination from residual hydraulic fluid, dirty grease, and cleaning agents.

4. ☐ Remove the access panel on the side of the tong directly adjacent to the shifter mechanism.

5. ☐ Clean the interior of the tong thoroughly, using either water (do not use a pressure washer), or an appropriate solvent-based grease-cutting cleaner such as Varsol. Ensure adequate containment is in place to prevent environmental contamination from residual hydraulic fluid, dirty grease, and cleaning agents. Make a note if any metal shavings or metal pieces are flushed out of the gear train cavity - if shavings or metal pieces are seen the tong must be overhauled before it is returned to service.

6. ☐ Inspect all fasteners and fastener safety wires (if equipped). Replace any missing fasteners - use Grade 8 bolts only unless otherwise specified. Re-torque all external fasteners to SAE specifications.

7. ☐ Repair or replace any damaged or missing external body parts, such as torque gauge mounts, hydraulic supports, safety door protectors, etc.

8. ☐ Perform a visual inspection of all fasteners and protruding body pieces (example: hydraulic valve mounts, inlet & outlet line supports, tong legs, shifter handle pivot lugs). Tighten or replace loose or missing fasteners. Farr recommends that damaged or missing body parts be repaired or replaced as soon as possible.

9. ☐ Inspect tong for signs of premature wear, or moving parts that are rubbing (bare metal where there used to be paint is a good indication of wear.

10. ☐ Inspect all paint - locations in which the paint has been damaged must be repaired prior to the tong being returned to service. Prepare areas to be painted to ensure they are free of grease, dirt, or solvent. Touch up using a solvent-based acrylic paint - "Farr Blue" is paint number RAL5005 (contact Farr sales for paint number for custom paint applications). Allow sufficient time for paint to dry before proceeding.

11. ☐ Inspect all external welds. Any weld that is cracked or separating must be repaired and repainted before returning the tong to service.

12. ☐ Perform a visual inspection of all lifting points - if visible damage is seen, including cracks, broken lugs, distorted metal, etc. replace damaged part(s) before placing tong in service. Also inspect all chains, master links, and turnbuckles - again, if any damage is noted replace the damaged part(s) before placing the tong in service. Refer to Section 2A of the technical manual (Sling/Load Bearing Device Safety) for information on recommended testing and recertification. Please note that turnbuckles with part number 101-3086 (short turnbuckles) use a high-strength pin which must be supplied by Farr.

"SHORT" TURNBUCKLES HAVING PART NUMBER 101-3086 EMPLOY HIGH-STRENGTH PINS WHICH MUST BE SUPPLIED BY FARR.

13. ☐ Rotate the gear train by hand, and use a flashlight to perform a visual inspection of the gear train through the access panel and the opening of the rotary gear while the gear train is being rotated. If gear damage or chips of metal are seen, the tong should be removed from service and overhauled to avoid further damage. Replace access panel when inspection is complete.

14. ☐ Inspect all jaws and dies in use for the maintenance interval. Inspect the jaw roller pins for signs of damage - replace pins if necessary. If the pins are welded in place, remove and quarantine the jaw until the weld is repaired. Ensure dies are secure in the jaw - replace worn dies if necessary. Ensure that the jaw rollers rotate freely.

15. ☐ Inspect backing pin(s). If cracked, broken, or bent it (they) must be replaced.

16. ☐ Inspect top and bottom brake band linings - replace if necessary. Unequal wear of the brake bands indicates that the brake band tension is not evenly adjusted. Refer to the maintenance section of the manual for instructions on properly adjusting brake bands.

17. ☐ Inspect door springs. Ensure the springs retain sufficient strength to be able to assist the opening of the door, and to keep the door open. The springs should also help to "snap" the door shut.

18. ☐ Inspect backup springs (if applicable). The rear extension springs should be equally extended, and the front leg springs should be equally compressed. Ensure that neither of the rear backup springs have been over-extended and lack sufficient tension to adequately support the backup. Ensure that neither of the front leg springs have been over-compressed, and still retain enough spring strength to support the front of the backup.

19. ☐ Extend all hydraulic cylinders, and inspect cylinder rods for signs of mechanical damage, flaking, or rust. Farr recommends that damaged cylinders be replaced prior to storage.

20. ☐ Perform a visual inspection of all hydraulic lines. Replace flexible lines if they appear to be cracked, fatigued, or have visible signs of wear from contact with a rigid object. If your tong is equipped with rigid hydraulic lines, replace any line that is dented or appears to be stressed or cracked.

21. ☐ Generously fill the gear train housing with grease through the access panel, and also through the opening in the rotary gear. Perform a full lubrication - refer to Maintenance section of manual to determine lubrication points.

22. ☐ Ensure main supply and return connections to the tong are fully made up. Re-connect the remainder of the hydraulic lines, and, if applicable, the electrical line to the turns counter.

FAILURE TO ENSURE THAT THE SELF-SEALING SUPPLY AND RETURN LINES ARE FULLY MADE UP MAY RESULT IN CATASTROPHIC EQUIPMENT FAILURE.

If using a stand-alone power unit, start it now - refer to the power unit technical manual for startup procedures. Listen to power unit for a moment to see if there are any unusual mechanical sounds (rubbing, grinding, excessive pump noise). If using a diesel unit, allow sufficient time for the engine to reach operating temperature before increasing engine RPM. Once engine is warm, gradually increase engine RPM until operating speed is reached.

23. ☐ Ensure that supply pressure is at or above the tong's specified operating pressure, and that the return pressure is less than 350 psi.

24. ☐ Perform a visual inspection of pressurized hydraulic lines. If any hydraulic fittings or hoses are leaking they must be repaired or replaced before proceeding.

25. ☐ Rotate tong for one minute, stop, and reverse the direction of rotation for another minute, ending with the opening of the rotary gear facing the gear train. De-energize the power unit, and perform another generous lubrication of the gear train, including the gear housing.

26. ☐ Energize power unit. Rotate tong for one minute, stop, and reverse the direction of rotation for another minute, ending with the opening of the rotary gear facing the gear train.

27. ☐ De-energize the power unit, and perform a third generous lubrication of the gear train, including the gear housing.

28. ☐ Re-energize power unit and extend all hydraulic cylinders. Inspect cylinder rods for signs of mechanical damage, flaking, or rust. Farr recommends that damaged cylinders be replaced.

29. ☐ Rotate tong in low gear for 5 minutes while monitoring pressurized seals and hydraulic lines. If a seal, line, or fitting begins to leak while tong is rotating, it must be replaced before the equipment is returned to service.

30. ☐ Rotate tong in high gear for 5 minutes while monitoring temperature of top and bottom bearing caps. If the bearing caps are hot to the touch (higher than approximately 50°C) replace the applicable bearings. Likewise if the tong is making unusual noises check for damaged bearings (see Maintenance Manual for all bearing locations).

31. ☐ Install load cell. If using a tension load cell, perform a visual inspection and replace any cracked, broken, or distorted components including links and chains. If using a compression load cell, replace any component that has been crushed or otherwise distorted through compression.

32. ☐ If applicable, inspect the load cell anchor pins (tension load cell only). Replace the anchor pins if cracking or metal distortion is seen.

33. ☐ If applicable, the weld securing the single load cell anchor to the bridge bar main plate must be inspected (compression load cell only). If the integrity of the weld has been compromised, the tong must be removed from service until the weld is repaired. The load cell beam will need to be disconnected and removed so the weld is visible. Before re-installing the beam, liberally grease the anchor pin before reinserting into the load cell beam.

34. ☐ Inspect load cell for damage or signs of stress. Check oil level in load cell and fill if necessary (refer to technical manual Section 7 or Section 8).

35. ☐ While rotating the cage plate, ensure that the jaws properly cam. If the jaws do not cam properly, the brake bands need to be tightened. Incrementally adjust both the top and bottom brake bands EQUALLY until proper cam action is achieved. Refer to the maintenance section of the manual for instructions on properly adjusting brake bands.

36. ☐ Perform a full functional test of the tong including, if applicable, backup components, lift cylinder, and float frame components. Report and correct any hydraulic leaks from the hydraulic valve bank, or from any hydraulic cylinders that are used.

37. ☐ Test safety door feature (if equipped). Begin rotating the tong at low speed, and open the tong door(s). If rotation does not immediately stop, this is an indication that the safety door mechanism is not operating correctly and the tong must be removed from service until the mechanism is repaired. Repeat the test while operating the tong in the opposite direction. If the safety door is operating correctly, cage plate rotation will not be inhibited once the door is closed and latched.

NEVER OPERATE YOUR EQUIPMENT WITH A BYPASSED OR MALFUNCTIONING SAFETY DOOR

38. ☐ Farr recommends that an anti-corrosive agent such as Tectyl® 506 be applied to all external unpainted surfaces (and chain slings) EXCEPT cylinder rods, jaw rollers, and rotary gear camming surfaces. Refer to manufacturer data sheets for proper application and safety information.

Once all of the above maintenance checklist items have been satisfactorily completed the tool may be returned to service.

4.L TUBULAR CONNECTION EQUIPMENT DE-COMMISSIONING & SHIPPING

Perform the following decommissioning procedures when removing tubular connection equipment from service, with the intent of short to long-term storage. These procedures are essential for ensuring proper protection of the equipment from environmental attack, and to aid in the quick turnaround when returning the equipment to service.

Store all o-rings, seals, packings, gaskets, etc. in strong moisture proof, airtight containers. Ensure that these items are not crushed, nicked, or otherwise damaged.

Do not perform any further actions or maintenance while the tong is connected to any hydraulic power supply. Farr recommends that all hydraulic lines are fully disconnected, and residual hydraulic pressure is bled off. Ensure adequate containment is in place to prevent environmental contamination from residual hydraulic fluid.

IN ORDER TO MAINTAIN THE INTEGRITY OF INSTALLED SEALS, MCCOY RECOMMENDS THAT THE MAXIMUM STORAGE INTERVAL NOT EXCEED ONE YEAR. AT LEAST ONCE PER YEAR ALL TUBULAR CONNECTION EQUIPMENT IN LONG-TERM STORAGE SHOULD BE RECOMMISSIONED AS PER SECTION 3.M. IF FURTHER STORAGE IS REQUIRED, THE EQUIPMENT SHOULD THEN BE PUT THROUGH ANOTHER DE-COMMISSIONING PROCEDURE.

DEPRESSURIZATION PROCEDURE IN PREPARATION FOR STORAGE:

1) Rotate the tong so that the opening in the rotary gear faces the gear train (towards the rear of the tong). Ensure tong and backup doors (if equipped) are closed. Fully extend the lift cylinder (if equipped). If mounted in a frame, retract the float cylinders (if equipped).
2) De-energize the power unit.
3) Repeatedly actuate the tong motor control valve lever IN BOTH DIRECTIONS to dissipate any residual pressure in the valve and motor.
4) Remove the hydraulic SUPPLY line from the equipment.
5) Repeatedly actuate the remaining control valve levers IN BOTH DIRECTIONS to dissipate any residual pressure in the remainder of the hydraulic control system.
7) Disconnect the hydraulic RETURN line from the equipment.
8) Disconnect remaining hoses such as case drains, or lines connected to the turns counter.

HYDRAULIC PRESSURES AS HIGH AS OPERATING PRESSURE MAY REMAIN TRAPPED IN SMALL AREAS OF THE EQUIPMENT. ENSURE ALL MAINTENANCE IS CARRIED OUT BY A QUALIFIED SERVICE TECHNICIAN, AND THAT ADEQUATE PERSONAL PROTECTIVE EQUIPMENT IS USED TO GUARD AGAINST PRESSURE-INDUCED INJURIES

1. ☐ Perform an initial wash of the tool in order to remove the majority of dirt and grease build-up. Ensure adequate containment is in place to prevent environmental contamination from residual hydraulic fluid and dirty grease.
2. ☐ Remove the access panel on the side of the tong directly adjacent to the shifter mechanism.
3. ☐ Clean the interior of the tong thoroughly, using either water (do not use a pressure washer), or an appropriate solvent-based grease-cutting cleaner such as Varsol. Ensure adequate containment is in place to prevent environmental contamination from residual hydraulic fluid, dirty grease, and cleaning agents. Make a note if any metal shavings or metal pieces are flushed out of the gear train cavity - if shavings or metal pieces are seen the tong must be overhauled before it is returned to service.
4. ☐ Clean the exterior of the tool thoroughly, using either water (do not use a pressure washer), or an appropriate solvent-based grease-cutting cleaner such as Varsol. Ensure adequate containment is in place to prevent environmental contamination from residual hydraulic fluid, dirty grease, and cleaning agents.
5. ☐ Inspect all fasteners and fastener safety wires. Replace any missing fasteners - use Grade 8 bolts only. Re-torque all external fasteners to SAE specifications.
6. ☐ Inspect backing pin(s). If cracked, broken, or bent it (they) must be replaced.
7. ☐ Repair or replace any damaged or missing external body parts, such as torque gauge mounts, hydraulic supports, safety door protectors, etc.
8. ☐ Inspect all paint - locations in which the paint has been damaged must be repaired prior to storage. Prepare areas to be painted to ensure they are free of grease, dirt, or solvent. Touch up using a solvent-based acrylic paint - "McCoy Grey" is paint number RAL7015. Allow sufficient time for paint to dry before proceeding.
9. ☐ Perform a liberal lubrication of the equipment - refer to Maintenance section of manual to determine lubrication points. Generously fill the gear train housing with grease through the access panel, and also through the opening in the rotary gear.
10. ☐ Connect the equipment to a hydraulic power unit. Ensure all lines are fully made up to prevent equipment damage from excessive back pressure. Do not neglect to connect the motor drain.

11. ☐ Energize power unit.

12. ☐ Rotate tong for one minute, stop, and reverse the direction of rotation for another minute, ending with the opening of the rotary gear facing the gear train. De-energize the power unit, and perform another generous lubrication of the gear train, including the gear housing.

13. ☐ Energize power unit. Rotate tong for one minute, stop, and reverse the direction of rotation for another minute, ending with the opening of the rotary gear facing the gear train.

14. ☐ De-energize the power unit, and perform a third generous lubrication of the gear train, including the gear housing.

15. ☐ Energize power unit, and rotate the tong for a final time, one minute in one direction, stop, and reverse the direction of rotation for another minute, this time ending with the rotary gear in the "open throat" position.

16. ☐ Extend all hydraulic cylinders, and inspect cylinder rods for signs of mechanical damage, flaking, or rust. Farr recommends that damaged cylinders be replaced prior to storage.

17. ☐ If you are using a frame-mounted tool, the tong must be lowered onto the backup in order to remove the risk of sudden and catastrophic movement when pressure is removed from the float cylinders. Cover the top of the backup with protective cloth to protect the paint on the backup. Place two wooden beams across the top of the tong, ensuring that the beams have a minimum size of 4" x 4" x the width of the tong. Cover the tops of the wooden beams with more protective cloth to prevent paint damage to the tong. When lowering the tong onto the beams, ensure that the beams come into flat contact with the bottom of the tong, away from bearing caps, brake bands, or other protrusions on the bottom of the tong. Ensure that the tong hanger chains are loose, but not dangling into contact with the hangers or top plate of the tong.

DEPRESSURIZATION PROCEDURE FOR STORAGE:

1) Rotate the tong to the "open throat" position.
2) Exercise each hydraulic cylinder several times - open the tong and backup doors (if equipped), retract and extend the remote backing pin ramp (if equipped), retract and extend the float cylinders. Leave all cylinders except for the door cylinders in their fully retracted position. The general idea is to have as little of the chrome cylinder rods exposed as possible.
3) De-energize the power unit.
4) Repeatedly actuate the tong motor control valve lever IN BOTH DIRECTIONS to dissipate any residual pressure in the valve and motor.
5) Remove the hydraulic SUPPLY line from the equipment.
6) Repeatedly actuate the remaining control valve levers IN BOTH DIRECTIONS to dissipate any residual pressure in the remainder of the hydraulic control system.
7) Connect a low-pressure air supply line (10 PSI or less) to the hydraulic supply line, and force a small amount of the remaining hydraulic fluid from the valve assembly - this will allow for thermal expansion of the hydraulic fluid if the equipment is stored or transported in high ambient temperatures. Failure to do this may result in damaged or destroyed seals in the equipment.
8) Disconnect the hydraulic RETURN line from the equipment.
9) Disconnect remaining hoses such as case drains, or lines connected to the turns counter.

18. ☐ If any hydraulic fittings or hoses are leaking they must be repaired or replaced before proceeding.

19. ☐ Wipe all excess grease from outside of equipment. Replace the access door panel. Use a solvent-based cleaner on rags to wipe all external surfaces to remove residual grease or hydraulic fluid. Once the outside surfaces have been de-greased, wipe all external surfaces with clean water to remove residual solvent.

20. ☐ Farr recommends that chain slings be removed and stored separately. Rigid slings and other rigid suspension devices may remain in place.

21. ☐ Apply grease or heavy oil to all exposed cylinder rods.

22. ☐ Farr recommends that an anti-corrosive agent such as Tectyl® 506 be applied to all external surfaces EXCEPT cylinder rods (including chain slings). Refer to manufacturer data sheets for proper application and safety information.

DO NOT ALLOW ANTI-CORROSIVE AGENTS TO CONTACT CYLINDER RODS. CYLINDER ROD DAMAGE WILL OCCUR.

23. ☐ Allow the anti-corrosive coating ample time to dry - refer to manufacturer data sheets for drying times at room temperature.

24. ☐ Wrap entire assembly in 100 gauge (1 mil) corrosion-inhibiting wrap, at least 3 layers thick. Attempt to ensure that the tool is well-sealed within the wrapping, including the bottom.

If possible, store in a sealed, climate controlled environment. If isolated storage is not available, Farr recommends storing your wrapped equipment in a secure, out-of-the-way location, using silica gel desiccant to reduce the humidity within the wrapping. As a guideline, use 125 g. of desiccant for each cubic metre of space, or 3.5 g. per cubic foot.

CALCULATION OF REQUIRED DESICCANT

1) Calculate the trapped air volume by measuring the outside dimensions of the tool to be stored, and treat that as the volume to be stored. For example, the external dimensions of a KT20000 20" power tong are 80.25" x 50.5" x 28", which calculates to an approximate volume of 113500 in^3, or 66 ft^3 (1.87 m^3).

2) Multiply the calculated air volume, in cubic feet, by the recommended amount of desiccant per cubic foot. Carrying forth the example used in the previous step, the required desiccant charge would be 3.5 g. x 66 ft^3, equaling 231 g. Several manufacturers offer silica gel desiccant in packaged quantities of 125 grams per bag, so two packages of desiccant would be required. Please keep in mind that this is a guideline only - more or less desiccant may be required in extreme environmental conditions.

For best corrosion resistance the equipment should be removed from storage and exercised on a regular basis, depending on the storage environment. Farr recommends that for equipment stored in a salt-water maritime or exposed dusty environment, repeat steps 9 through 24 monthly. For equipment stored in isolated storage in a non-maritime environment, repeat steps 9 through 24 quarterly. Replace desiccant packs at this time - depleted desiccant packs may be treated as regular dunnage.

SHIPPING INSTRUCTIONS

The following procedure lists the steps to be followed to prepare your tong for shipping.

1. If not already done remove accessories (tong jaws, load cell, torque gauge, etc.) McCoy recommends wrapping these items in protective wrap and placing in a separate wooden crate.
2. Place the equipment on a sturdy pallet constructed of 4" x 4" cross-members and 2" x 4" flooring. McCoy recommends placing a 2" x 6" board across the width of the tong under the legs (see Illustration 4.L.1). Ensure the pallet is large enough to accommodate the wooden crate containing the tong accessories.

ILLUSTRATION 4.L.1: SHIPPING INSTRUCTIONS - PALLET

Shipping Instructions (Continued):

3. Use a crane to support the chain sling (if equipped). Wrap the chain sling with bubble wrap or another similar protective wrapping, and secure the wrapping with tape. Lower the wrapped chain sling so it sits inside the opening of the tong.

Illustration 4.L.2: Shipping Instructions - Wrapping Chain Sling

4. Do not allow the backup (if equipped) to "float" on its support springs during shipping. Build a sturdy wooden support structure under the front and back of the backup to support the weight of the backup and release the compression on the springs. Strap the backup to the support blocks and pallet independent of the tong, using minimum 3/4" x 0.029" metal strapping in at least two locations. Place strapping as close to the backup supports as possible, and use caution not to entrap any flexible hydraulic hoses beneath the strapping. Before tightening strapping, place strapping protectors wherever the metal strapping comes into contact with the equipment.

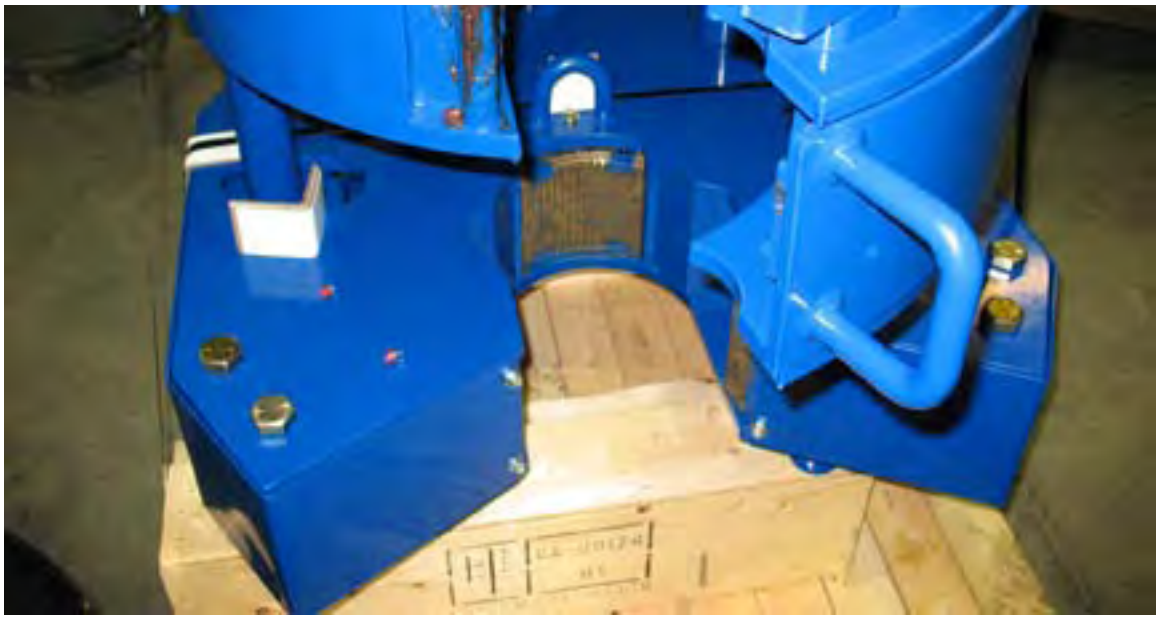


Illustration 3.K.3: Shipping Instructions - Backup Support

SHIPPING INSTRUCTIONS (CONTINUED):

5. Securely strap the equipment in place using metal strapping. Place strapping as close to the cross-members under the equipment legs as possible, and use caution not to entrap any flexible hydraulic hoses beneath the strapping (guide strapping through beneath the hydraulic hoses). Use the following guidelines to determine the strapping requirements:

   Assemblies weighing 1000 lbs. (454 kg.) or less:

   3/4" x 0.029" metal strapping, 3320 lbs. (1509 kg.) tensile strength
   Minimum two straps

   Assemblies weighing more than 1000 lbs. (454 kg.) or less:

   1-1/4" x 0.031" metal strapping, 5500 lbs. (2500 kg.) tensile strength
   Minimum two straps for assemblies weighing less than 5000 lbs. (2273 kg.)
   Minimum three straps for assemblies weighing more than 5000 lbs. (2273 kg.)

   Before tightening strapping, place strapping protectors wherever the metal strapping comes into contact with the equipment.

   Place the wooden crate containing the tong accessories on the crate next to the equipment. Strap the crate to the pallet using 3/4" x 0.029" metal strapping (see Illustration 4.L.4).

ILLUSTRATION 4.L.4: SHIPPING INSTRUCTIONS - STRAPPING EQUIPMENT TO PALLET

   If it is not practical to place larger loose items in a wooden crate, ensure they are also securely strapped to the pallet using 3/4" x 0.029" metal strapping.

6. Use a large polyethylene shipping bag (sometimes called a pallet cover) to completely enclose the equipment. Seal polyethylene bag to the pallet using 1 mil polyethylene wrap. Use the wrap to conform the plastic cover to the general shape of the equipment, but do not wrap so tight that sharp edges on the equipment perforate the cover.
7. McCoy recommends enclosing the equipment in a sturdy shipping crate which is securely fastened to the pallet.

4.M TUBULAR CONNECTION EQUIPMENT RE-COMMISSIONING PROCEDURE

Perform the following recommissioning procedures when removing tubular connection equipment from short or long-term storage back into regular service. These procedures are essential for ensuring proper equipment preparation and operation. The following procedures also assume that the decommissioning and storage procedures recommended by Farr have been strictly observed.

1. ☐ Remove all protective plastic wrapping. If there are desiccant packs with the assembly, they may be disposed of with the regular garbage.
2. ☐ Remove the access panel on the side of the tong directly adjacent to the shifter mechanism.
3. ☐ Wipe excess grease or heavy oil from exposed cylinder rods.
4. ☐ If applicable, re-connect chain sling to lifting lugs. Perform a visual inspection of all lifting points - if visible damage is seen, including cracks, broken lugs, distorted metal, etc. replace damaged part(s) before placing tong in service. Also inspect all chains, master links, and turnbuckles - again, if any damage is noted replace the damaged part(s) before placing the tong in service. If your company requires yearly certification of lifting equipment, ensure that the most recent test date falls within the past year. Perform recertification if necessary.
5. ☐ Perform a liberal lubrication of the equipment - refer to Maintenance section of manual to determine lubrication points. Generously fill the gear train housing with grease through the access panel, and also through the opening in the rotary gear.
6. ☐ Connect the equipment to a hydraulic power unit. Ensure all lines are fully made up to prevent equipment damage from excessive back pressure. Do not neglect to connect the motor drain.

FAILURE TO ENSURE THAT THE SELF-SEALING SUPPLY AND RETURN LINES ARE FULLY MADE UP MAY RESULT IN CATASTROPHIC EQUIPMENT FAILURE.

7. ☐ Energize power unit.
8. ☐ Ensure that supply pressure is at or above the tong's specified operating pressure, and that the return pressure is less than 350 psi.
9. ☐ Perform a thorough inspection of pressurized hydraulic lines and fittings. Any leaking hydraulic fluid lines or fittings must be replaced before the equipment is returned to service.
10. ☐ Perform a thorough inspection of all seals. Any seal that is leaking or "weeping" must be replaced before the equipment is returned to service.
11. ☐ Rotate tong in low gear for 5 minutes while monitoring pressurized seals and hydraulic lines. If a seal, line, or fitting begins to leak while tong is rotating, it must be replaced before the equipment is returned to service. Finish this step with the rotary gear opening facing the gear train. De-energize the power unit.
12. ☐ Inspect all flexible hydraulic lines for signs of wear, blistering, or any other signs of potential failure - replace if signs of potential failure are identified.
13. ☐ Inspect the gear train housing. If the amount of grease is inadequate, liberally grease the gear train through the access panel, and through the opening in the rotary gear.
14. ☐ Inspect top and bottom brake band linings - replace if necessary. Unequal wear of the brake bands indicates that the brake band tension is not evenly adjusted. Refer to the maintenance section of the manual for instructions on properly adjusting brake bands. Ensure that all grease is wiped from brake band linings and the parts of the cage plates that come into contact with the brake band linings
15. ☐ Re-install access panel. Install a set of pre-inspected jaws that are the correct size for the pipe or casing being run.
16. ☐ Install load cell. If using a tension load cell, perform a visual inspection and replace any cracked, broken, or distorted components including links and chains. If using a compression load cell, replace any component that has been crushed or otherwise distorted through compression.
17. ☐ If applicable, inspect the load cell anchor pins (tension load cell only). Replace the anchor pins if cracking or metal distortion is seen.
18. ☐ If applicable, the weld securing the single load cell anchor to the bridge bar main plate must be inspected (compression load cell only). If the integrity of the weld has been compromised, the tong must be removed from service until the weld is repaired. The load cell beam will need to be disconnected and removed so the weld is visible. Before re-installing the beam, liberally grease the anchor pin before reinserting into the load cell beam.
19. ☐ Re-energize power unit.

20. ☐ Perform a full functional test of the equipment including, if applicable, backup components and float frame components. Report and correct any hydraulic leaks from the hydraulic valve bank, or from any hydraulic cylinders that are used.

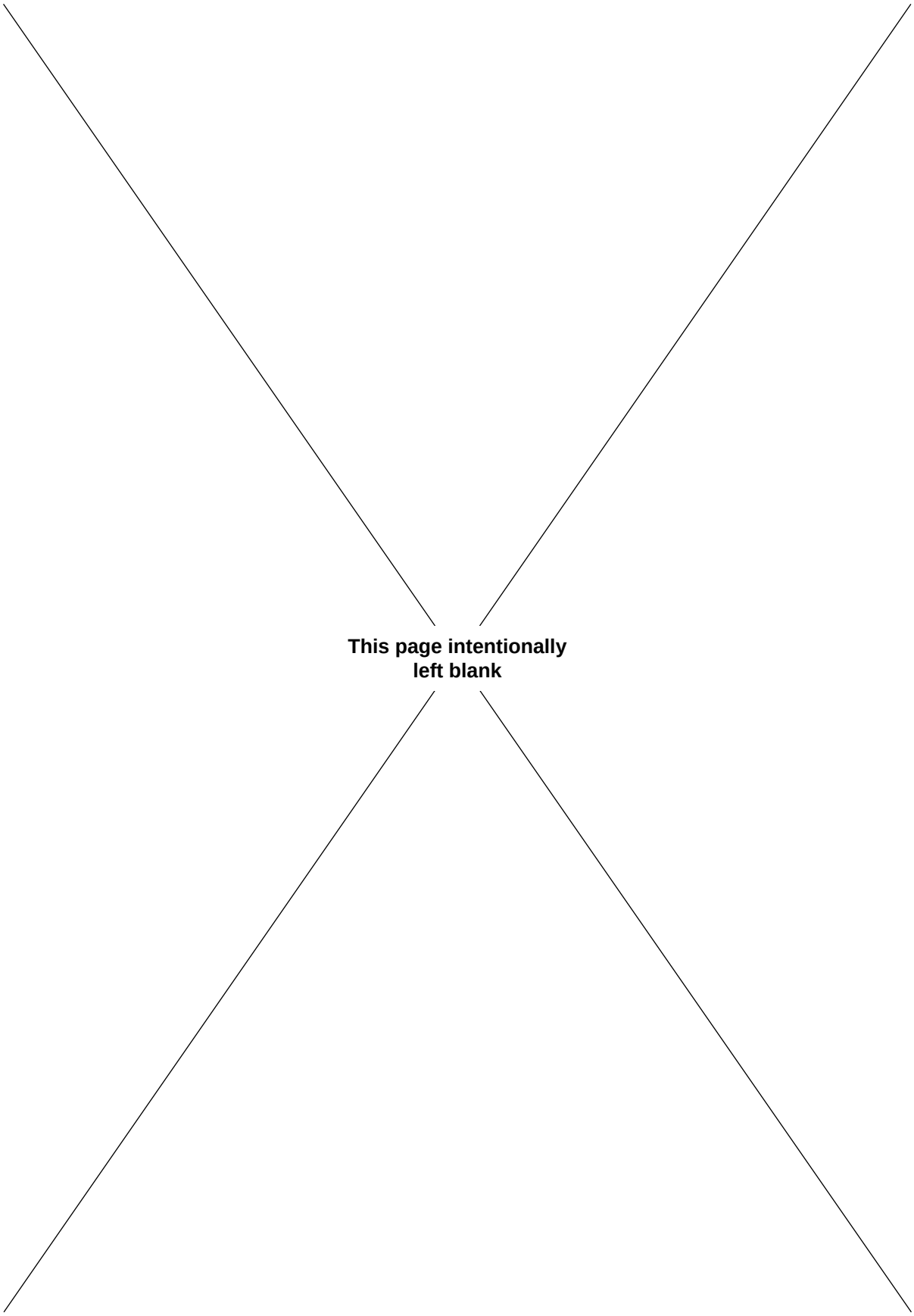
21. ☐ If using a frame-mounted tong and backup system, raise the tong off the beams that it is resting upon. Remove the beams and protective cloths - inspect the paint on top of the backup and the bottom of the tong to ensure it has not been damaged by the beam.

22. ☐ Test safety door feature (if equipped). Open the tong door(s), and attempt to rotate the cage plate at low speed (low gear) in both directions (makeup and breakout). If cage plate begins rotating, the safety door mechanism is not functional, and the tong must be removed from service until the safety door mechanism can be repaired. If the safety door is operating correctly, cage plate rotation will not be inhibited once the door is closed and latched.

NEVER OPERATE YOUR EQUIPMENT WITH A BYPASSED OR MALFUNCTIONING SAFETY DOOR

23. ☐ While rotating the cage plate, ensure that the jaws properly cam. If the jaws do not cam properly, the brake bands need to be tightened. Incrementally adjust both the top and bottom brake bands EQUALLY until proper cam action is achieved.

24. ☐ When all of the previous steps are completed, you may return your re-commissioned equipment to service.



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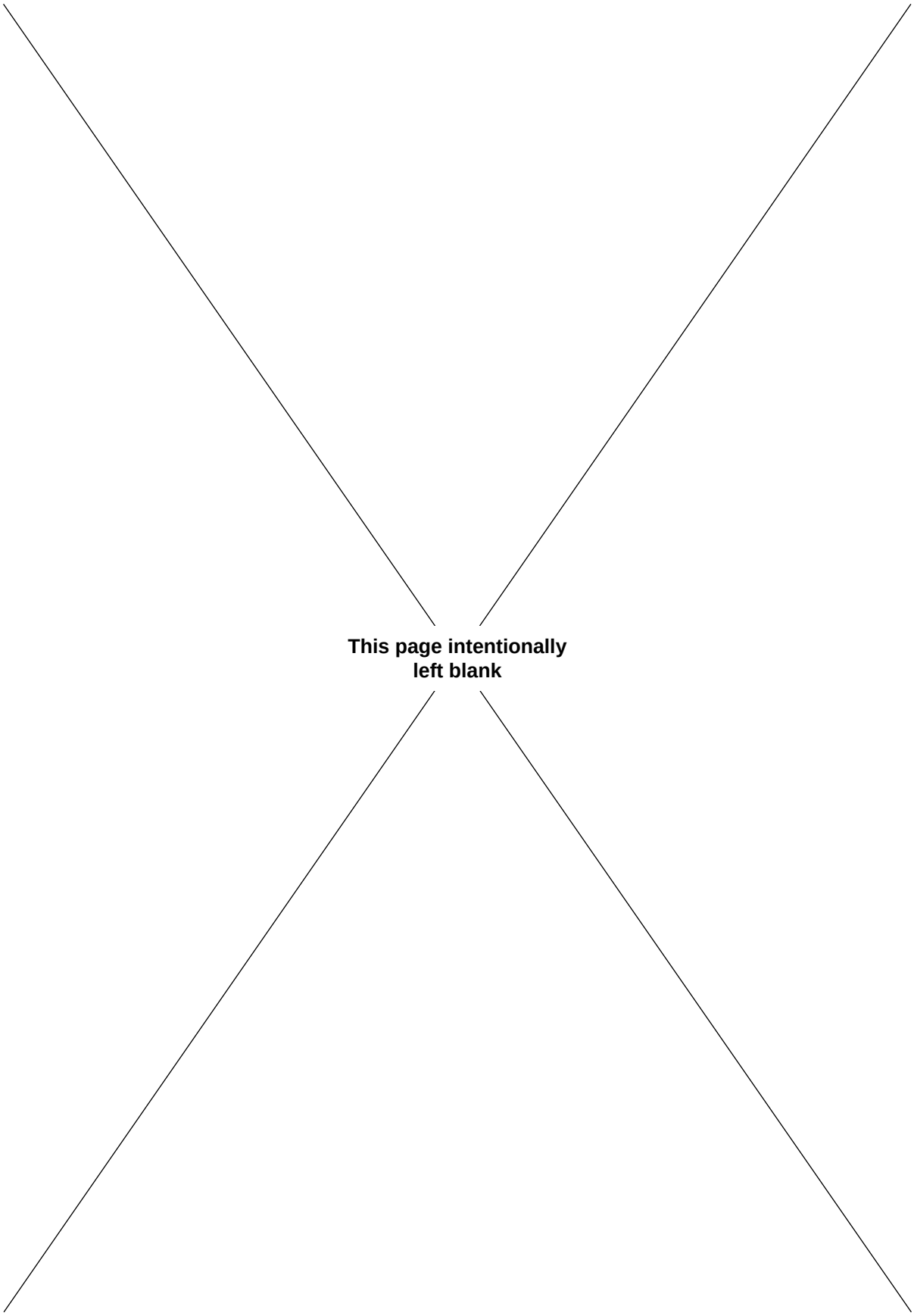
SECTION 5: TROUBLESHOOTING



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Adequate maintenance and proper fluid selection is essential for minimizing hydraulic-related failures. All troubleshooting must be performed by a technician trained in hydraulic systems, and familiar with the equipment design, assembly and operation.

The following troubleshooting instructions are intended to be guidelines only. Any faults not solved through the use of this guide should be referred to our engineering department for their evaluation and recommendations.

5.A TONG WILL NOT DEVELOP SUFFICIENT TORQUE

	POSSIBLE PROBLEM	SOLUTION(S)
1	Malfunctioning relief valve on tong hydraulic circuit	See Section 4.B, Relief Valve Troubleshooting
2	Directional valve is leaking	Check directional valve. Neutral position should return fluid directly to the reservoir. Replace or repair valve to ensure correct operation
3	Power unit is not producing adequate pressure	Troubleshoot power unit (see user's manual for your particular unit)
4	Poor hydraulic pressure at the tong despite adequate pressure at the power unit, or excessive back pressure in the return line.	Restrictions exist in line between power unit and tong. Inspect integrity of self-sealing couplings to ensure they are allowing full fluid flow. Check to ensure no other restrictions exist (contaminated catch screens or filters, for example)
5	Fluid viscosity is not appropriate (too high or too low)	Ensure hydraulic fluid being used is the viscosity recommended by McCoy Drilling & Completions. Power unit pump may not prime if fluid is too heavy, and the hydraulic system will overheat if fluid is too light. Replace with proper viscosity fluid
		Hydraulic fluid viscosity is affected by environmental conditions. Ensure the fluid being used is suitable for high or low temperatures. Replace with proper viscosity fluid for the operating conditions if necessary
6	Worn or damaged tong motor causing slippage	Replace or repair worn or damaged motor
7	Damaged bearings or gears causing excessive drag	Replace or repair worn or damaged gears or bearings
8	Jaws slipping on pipe	Ensure jaw dies are not worn to the point that they cannot grip. Ensure the correct sized jaws are in use
9	Torque gauge is indicating incorrectly	Incorrect gauge is being used. Ensure gauge is the proper range, and has been properly calibrated for the arm length of the equipment in use
		Gauge has been damaged. Check gauge operation and calibration on independent system
		Gauge has mistakenly been married to an incorrect load cell
10	Load cell is measuring incorrectly	Incorrect load cell is being used
		Air is trapped in torque measuring circuit (load cell, hydraulic line, or gauge. Refer to torque measurement troubleshooting in Section 6 of this manual
		Load cell has been damaged. Replace load cell, or return to McCoy for repair and re-calibration

MCCOY DRILLING & COMPLETIONS GUARANTEES CALIBRATION OF A LOAD CELL/TORQUE GAUGE ASSEMBLY FOR A PERIOD OF ONE YEAR. MCCOY SUGGESTS THAT THE LOAD CELL/TORQUE GAUGE ASSEMBLY BE RETURNED TO THE FACTORY FOR RE-CALIBRATION ON A YEARLY BASIS.

	POSSIBLE PROBLEM	SOLUTION(S)
11	Incorrect motor speed selected (applies to 2-speed motors only)	Maximum torque can only be developed when LOW motor speed (maximum hydraulic displacement) is selected.
12	Incorrect tong gear selected	Maximum torque can only be developed when LOW motor gear is selected

5.B RELIEF VALVE IS INCORRECTLY SET OR NOT FUNCTIONING

	POSSIBLE PROBLEM	SOLUTION(S)
1	Relief pressure set too low, resulting in insufficient tong torque	Adjust setting (See following procedure):
	Relief pressure set too high, resulting in crushed pipe or gear train failure	

a. If your tong is equipped with a system pressure indicator proceed to step "f". If your tong does not have a system pressure indicator, a temporary 0 - 3000 PSI indicator must be installed on the hydraulic inlet.

b. Isolate your tong from hydraulic power, and depressurize following the procedure in section 3.D.

c. Tee in a temporary indicator at the safety door supply pressure port. Ensure all hydraulic connections are performed by a qualified hydraulic technician.

ILLUSTRATION 5.B.1: RELIEF VALVE TROUBLESHOOTING - TEMPORARY GAUGE INSTALLATION

d. Re-establish hydraulic power to your tong. Ensure that no equipment functions are active.

e. Loosen the locking nut on the pressure relief valve.

f. Open the tong door to activate the safety door system and inhibit tong rotation.

g. Activate motor control valve. Observe the pressure displayed on the pressure indicator. Adjust the relief valve until the pressure indicated is at the maximum system pressure specified on the specifications page (maximum system pressure is the pressure at which your tong achieves its specified torque).

DO NOT ADJUST PRESSURE RELIEF TO A SETTING THAT ALLOWS HIGHER THAN MAXIMUM SYSTEM PRESSURE. DOING SO CREATES A POTENTIAL FOR SERIOUS INJURY OR DEATH, AND MAY CAUSE CATASTROPHIC EQUIPMENT FAILURE.

h. Release the motor control valve and tighten the locking nut on the pressure relief valve.

i. Isolate your tong from hydraulic power, and depressurize following the procedure in section 3.D.

j. Close the tong door, and remove the temporary pressure indicator. Restore the safety door pressure supply line to factory specifications. Verify that safety door is operating correctly (see section 2.H.5.11).

Continued on next page ...

5.B RELIEF VALVE IS INCORRECTLY SET OR NOT FUNCTIONING (CONTINUED):

	POSSIBLE PROBLEM	SOLUTION(S)
2	Relief cannot be adjusted to maximum system pressure (high fluid bypass results in low system pressure	Debris on valve seat
		Valve spring is broken
		Valve spring has lost spring force due to continuous tension

PROCEDURE:

a. Isolate your tong from hydraulic power, and depressurize following the procedure in section 3.D

b. Loosen the locking nut on the pressure relief valve.

c. Use a large flat-head screwdriver to completely un-thread the poppet and spring from the relief assembly.

d. Inspect the relief valve spring, poppet, and valve seat.

e. If no debris is found in relief valve and if seat and poppet are undamaged, replace relief valve spring.

f. Reassemble relief valve.

g. Relief valve must be re-set to allow maximum system pressure. Follow the procedure in Step 1 of this section to properly adjust relief valve.

h. If maximum system pressure still cannot be reached, replace the entire relief valve assembly.

5.C SAFETY DOOR DOES NOT OPERATE OR IS MALFUNCTIONING

	POSSIBLE PROBLEM	SOLUTION(S)
1	Safety door switch requires adjustment.	Adjust switch as per section 3.F.5
2	Safety door switch has failed	Test safety door switch for proper function and replace if necessary
3	Contamination in hydraulic lines	Ensure all three flexible hydraulic lines to safety door switch are free-flowing
4	Pilot-to-open valve in safety door valve block is malfunctioning.	Remove each valve. Inspect seats and springs. Replace valve(s) if damage is seen on valve seats, or if spring appears to be damaged or broken.

5.D TONG RUNNING TOO SLOWLY

	POSSIBLE PROBLEM	SOLUTION(S)
1	Obstruction in tong hydraulic circuit preventing adequate flow	Inspect self-sealing couplings to ensure they are properly engaged
		The main hydraulic lines (supply and discharge) to the tong are obstructed. Remove and clean if required
2	Power unit is not producing adequate flow or pressure	Troubleshoot power unit (see user's manual for your particular unit)
3	Tong motor is excessively worn and is leaking hydraulic fluid past the vanes	Replace motor, or rebuild as per Section 7 of this manual
4	Bearings in gear train and rotary section are excessively worn	Overhaul tong. See Section 3 of this manual for tong overhaul procedures
5	Shifter has malfunctioned and the tong is not shifting to high gear	Inspect and repair shift mechanism as necessary
6	Hydraulic fluid viscosity too high	Ensure hydraulic fluid meets McCoy Drilling & Completions specifications
		Ensure hydraulic fluid is appropriate for climatic conditions, especially during cold-weather operation
7	By-pass valve not functioning	Check and repair

5.E FAILURE OF JAWS TO GRIP PIPE

	POSSIBLE PROBLEM	SOLUTION(S)
1	Dies have become too dull to provide adequate grip	Replace dies
2	Incorrect jaws are being used	Double-check jaw size to ensure they are rated for the diameter of pipe or casing being run
3	Incorrect dies are being used	Ensure dies loaded in the jaws are appropriate for the type of pipe or casing being run
4	Brake band(s) is (are) insufficiently adjusted, not allowing jaws to cam properly	Adjust brake bands to give proper resistance to cage plates
5	Jaw roller broken or worn	Remove jaw assembly and inspect. Replace rollers that are visibly "flat-spotted" or otherwise damaged

5.F FAILURE OR DIFFICULTY OF TONG TO SHIFT

	POSSIBLE PROBLEM	SOLUTION(S)
1	Bent or broken shifter yoke	Inspect components through inspection door. Replace shifter yoke if necessary.
2	Bent or broken shifter shaft	Replace
3	Locking nuts on shifting shaft have loosened and position of yoke has changed	Reposition yoke and re-tighten locking nuts
4	Shifting yoke has come loose from shifting shaft	Inspect yoke and inspect for damage. If free of damage, replace on shaft and tighten locking set screws
5	Shifting mechanism requires adjustment	Adjust shifting mechanism - see Section 3.F.2

5.G GENERAL COMMENTS

The following factors generally contribute to poor hydraulic operation and premature wear of equipment:

1. Contaminated hydraulic fluid due to overuse, overheating, or inadequate fluid filtration.
2. Unsuitable hydraulic fluid, especially in extreme climatic conditions.
3. Defective packing or seals in components of the hydraulic system.
4. Poor or incomplete hydraulic system training. Users must be fully qualified to operate the equipment, and have complete understanding of the hydraulic system.

If your hydraulic troubleshooting procedures involve flow and pressure tests at the power unit, McCoy Completions & Drilling recommends construction of a test rig that can easily be connected to the main suction and discharge ports of the power unit.

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SECTION 6: PARTS & ASSEMBLIES

CRITICAL SPARE PARTS

The critical spare parts listed on page 6.2 identifies those parts that, if missing or damaged, results in one of the following possibilities:

- exposure of the operator(s) to a hazard while operating the equipment
- the equipment cannot be operated in a safe manner
- the equipment is inhibited from operating at all

McCoy recommends having the specified quantities of all critical spare parts on hand at all time. The parts indicated in **red** indicate essential health and safety items. Failure to replace damaged essential health and safety components will present immediate danger to personnel. McCoy strongly recommends that the equipment is removed from service until the damaged or missing components can be replaced.

The quantities listed in the tables on the following two pages are ***total*** quantities that McCoy recommends having on hand at all times. See individual parts & assemblies pages to see the quantity of each part required for each assembly.

MISC TONG & BACKUP PARTS		
Description	**Part Number**	**Qty. Required**
Clutch drive gear	1234-00-04	1
Shifting collar	997-HT-62	1
Threaded shifter detent tube	101-0019	1
Shifting shaft	101-5999	1
Shifting fork	101-6169	1
Backing pin	101-4994	1
Motor gear	997-A10-149	1
Door spring stop cylinder	101-0069	1
Safety door cam	101-5598	**1**
Lifting link	02-0516	**1**
Rigid sling pin	AK00-056	**2**
FASTENERS & FITTINGS		
Description	**Part Number**	**Qty. Required**
External Snap Ring (Clutch Drive Gear Retainer)	1234-00-04	1
3/8" UNC x 3/8" Hex Socket Set Screw (Motor Gear)	09-0106	2
¾" UNC x 9" hex bolt (rigid sling)	09-1322	**1**
3/16" hitch pin (rigid sling)	02-0028	**2**
HYDRAULIC COMPONENTS		
Description	**Part Number**	**Qty. Required**
Relief Cartridge (DVA35)	10-0010R	**1**
Two-speed hydraulic motor	87-0008	1
Safety door hydraulic switch	02-E0190	**1**
Pilot-to-open valve (safety door)	08-1625	**1**
Valve cartridge (backup)	08-1053	1
Hydraulic Hose - Lift Cylinder Supply (If lift cylinder is installed)	02-0934H	**1**
High-Visibility Protective Wrap, Lift Cylinder Hose (If lift cylinder is installed)	02-E0203	**1**
Hydraulic Hose Assembly - Backup 55" "A" Side	02-1011	1
Hydraulic Hose Assembly - Backup 52" "B" Side	02-1012	1
High-Visibility Protective Wrap, Backup Hydraulic Hose	02-E0204	1
JAW COMPONENTS		
Description	**Part Number**	**Qty. Required**
Jaw pivot bolt	AK10-056	**2**
Jaw Roller	AK21-JR-1_750	**2**
Jaw Pin	AK21-JP	**2**
Standard 3-⅞" Die Insert	13-0008-314-0	48

ITEMS ON THE CRITICAL SPARE PARTS LIST MARKED IN RED INDICATE ESSENTIAL HEALTH & SAFETY ITEMS. FAILURE TO REPLACE DAMAGED ESSENTIAL HEALTH & SAFETY ITEMS WILL PRESENT IMMEDIATE DANGER TO PERSONNEL OR EQUIPMENT. HAVE THESE ITEMS ON HAND AT ALL TIMES. STOP WORK AND QUARANTINE TONG UPON DISCOVERY OF DAMAGED OR DEFECTIVE HEALTH AND SAFETY COMPONENTS UNTIL PARTS CAN BE REPLACED.

RECOMMENDED (ONE YEAR) SPARE PARTS

McCoy suggests stocking the spare parts listed in the table on pages 6.3 and 6.4. Although these are not critical spare parts, stocking these components may significantly decrease equipment down time in the event of long lead times from the factory.

The quantities listed in the table on pages 6.3 and 6.4 are ***total*** quantities of each part that McCoy recommends stocking. See individual parts & assemblies pages to see the quantity of each part required for each assembly.

MISC TONG PARTS		
Description	**Part Number**	**Qty. Recommended**
Top clutch spacer	AK01-205	1
Detent ball (shifter)	02-0018	1
Detent spring (shifter)	997-0-64	1
Top shifter bushing (threaded)	101-0020	1
Backing pin knob	02-0017	1
Lined brake band weldment	101-4999	4
Door latch spring	997-13D	1
Rear leg spring	02-E0163	1
Front leg washers	AK06-603	1
Front leg spring	AK06-606	1
Bottom leg collar	AK06-604	1
Backup door spring	02-E0103	1
Backup door pivot bolt	02-E0101	1
BEARINGS & BUSHINGS		
Description	**Part Number**	**Qty. Recommended**
Cylindrical roller bearing (pinion)	1234-08-01B	2
Top clutch bearing	02-0077	1
Bottom clutch bearing	02-0076	1
Cam follower	02-0016	8
Cam follower	SSCF-1500	8
Door latch thrust washer	02-E0125	1
Door latch bushing	02-E0124	2
Tong door bushing	02-E0126	2
Backup door bushing	02-E0102	1
FASTENERS & FITTINGS		
Description	**Part Number**	**Qty. Recommended**
¼" UNF straight grease fitting	02-0070	2
Grease fitting, ⅛" NPT	02-0005	4
⅛" NPT 90° grease fitting	02-0093	4
Outside snap ring (clutch drive gear)	1234-00-04	1
5/16" x 1-½" clevis pin (shifting handle pivot)	09-0256	1
5/16" x 1" clevis pin (shifting shaft)	02-0020	1
7/16" UNF hex jam nut (shifter detent force adjust)	09-5508	1
7/16" UNF x 1-1/4" hex bolt (shifter detent force adjust)	09-1608	1

Continued on next page...

RECOMMENDED (ONE YEAR) SPARE PARTS (Continued):		
FASTENERS & FITTINGS		
Description	**Part Number**	**Qty. Recommended**
Hitch pin 0.0930" x 1-⅛" (shifter)	02-0274	2
⅜" UNC threaded stud (backing pin)	101-4058	1
⅝" UNF thin nylock nut (cam followers)	09-5513	8
⅞" narrow flat washer (cam followers)	09-5123	8
⅞" UNF nylock jam nut (cam followers)	09-5722	8
½" x 1-½" hex socket head shoulder screw (brake band pivot)	09-1113	2
½" UNC x 3-¾" hex socket head cap screw (brake band adjust)	25-6001	1
1" external retaining ring (backup clamp cylinder retainers)	02-0697	2
¾" narrow flat washer (backup door)	09-5013	1
¾" UNC nylock nut (backup door)	1429-39-02	1
HYDRAULICS		
Motor seal kit	87-7110	1
Motor speed control valve	10-9035	1
DVA35 Seal Kit	07-0004	1

PARTS REQUIRED FOR OVERHAUL

McCoy recommends replacing all parts listed in the tables on pages 6.5 - 6.6 when overhauling your equipment.

The parts indicated in red indicate essential health and safety items. McCoy strongly recommends replacing these components when overhauling your equipment.

The quantities listed in the table on page 6.5 - 6.6 are ***total*** quantities of each part that McCoy recommends stocking for the purpose of overhauling your tong. See individual parts & assemblies pages to see the quantity of each part required for each assembly.

ITEMS ON THE CRITICAL SPARE PARTS LIST MARKED IN RED INDICATE ESSENTIAL HEALTH & SAFETY ITEMS. MCCOY STRONGLY RECOMMENDS REPLACING ALL ESSENTIAL HEALTH & SAFETY ITEMS WHEN OVERHAULING YOUR EQUIPMENT.

MISC TONG PARTS		
Description	**Part Number**	**Qty. Required**
Pinion bearing spacer	1400-89A	1
Clutch drive gear	997-HT-61	1
Top clutch spacer	AK01-205	1
Top clutch bearing spacer	AK01-204	1
Low clutch gear	997-HT-52	1
Splined clutch shaft	AK01-202	1
Shifting collar	997-HT-62	1
High clutch gear	997-HT-51B	1
Bottom clutch spacer	997-99	1
Clutch o-ring	08-1240	1
Detent ball	02-0018	1
Detent spring	997-0-64	1
Shifting shaft	101-5999	1
Shifting fork	101-6169	1
Jaw pivot bolt	AK10-056	4
Backing pin	101-4994	1
Cam follower (rotary gear guide, tong only)	02-0016	40
Cam follower (rotary gear / backup cam ring support)	SSCF1500	72
Motor Gear	997-A10-149	1
Lined Brake Band Weldment	101-4999	4
Door latch spring	997-13D	1
Door spring stop cylinder	101-0069	1
Rigid sling adjustment helix	1053-1-H	1
Lifting link	02-0516	1
Rigid sling pin	AK00-056	2
Backup door spring	02-E0103	1
BEARINGS & BUSHINGS		
Cylindrical roller bearing (rotary idler)	02-E0104	2
Idler bearing (pinion idler)	02-0075	1
Cylindrical roller bearing (pinion)	1234-08-01B	2
Top clutch bearing	02-0077	1
Needle roller bearing (clutch)	12-1404	4
Bottom clutch bearing	02-0076	1
Door latch thrust washer	02-E0125	1
Door latch bushing	02-E0124	2

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OVERHAUL PARTS (CONTINUED)		
BEARINGS & BUSHINGS		
Description	**Part Number**	**Qty. Required**
Door bushing	02-E0126	2
Backup door bushing	02-E0102	1
FASTENERS & FITTINGS		
Description	**Part Number**	**Qty. Required**
Grease fitting, ¼" UNF straight thread	02-0070	2
Grease fitting, ⅛" NPT	02-0005	5
⅛" NPT 90° grease fitting	02-0093	7
Internal retaining ring (rotary idler)	02-E0105	1
Bearing retainer (pinion idler)	02-0008	1
Gear retainer (pinion idler)	02-0009	1
External snap ring (clutch drive gear retainer)	1234-00-04	1
5/16" x 1-½" clevis pin (shifting handle pivot)	09-0256	1
5/16" x 1" clevis pin (shifting shaft)	02-0020	1
7/16" UNF hex jam nut (shifter detent force adjust)	09-5508	1
7/16" UNF x 1-¼" hex bolt (shifter detent force adjust)	09-1608	1
¼" UNC x ⅜" hex socket set screw	09-0107	3
Hitch pin 0.0930" x 1-⅛" (shifter clevis pin restraints)	02-0274	2
⅝" UNF thin nylock nut (cam follower 02-0016)	09-5513	40
⅞" narrow flat washer (cam follower SSCF1500)	09-5123	72
⅞" UNF nylock jam nut (cam follower SSCF1500)	09-5722	72
⅜" UNC x ⅜" hex socket set screw (motor gear retainers)	09-0106	2
¾" UNC x 9" hex bolt (rigid sling helix/lifting link)	09-1322	1
¾" UNC nylock nut (rigid sling helix/lifting link)	1429-39-02	1
3/16" hitch pin (rigid sling pin security)	02-0028	4
Backup door pivot bolt	02-E0101	1
¾" narrow flat washer (backup door pivot)	09-5013	1
¾" UNC nylock nut (backup door pivot)	1429-39-02	1
HYDRAULIC COMPONENTS		
Description	**Part Number**	**Qty. Required**
Motor seal kit	87-7110	1
DVA35 Seal Kit	07-0004	1
Relief Cartridge (DVA35)	10-0010R	1
Relief Cartridge (Safety Door)	08-1625	1
Hydraulic Hose - Lift Cylinder Supply (If lift cylinder is installed)	02-0934H	1
High-Visibility Protective Wrap, Lift Cylinder Hose (If lift cylinder is installed)	02-E0203	1

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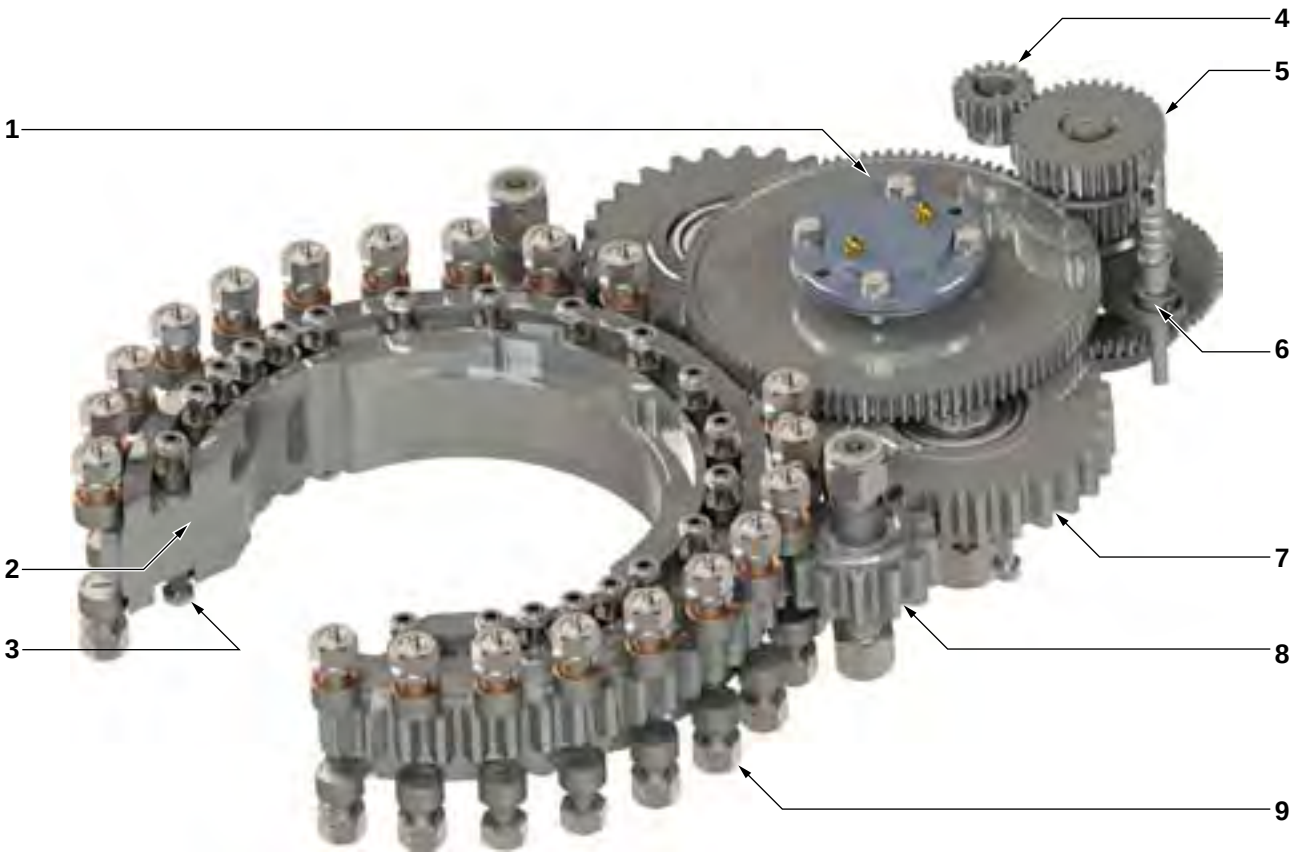

Illustration 6.1: HD-9-⅝" Gear Train ISO View

ITEM	TYPE	DESCRIPTION	QTY	PART NUMBER
1	Assembly	Pinion gear assembly (see Pp. 6.14 - 6.15)	1	PA-LW-9625
2	Part	Rotary gear	1	AK01-001-KT
3	Part	Cam follower	40	02-0016
4	Part	Motor gear	1	997-A10-149
5	Assembly	Clutch assembly (see Pp 6.16 - 6.17)	1	CA-LW-9625
6	Assembly	Shifting shaft & shifting fork (See Pp. 6.18 - 6.19)	1	
7	Assembly	Pinion idler assembly (See Pp. 6.12 - 6.13)	2	PIA-LW-9625
8	Assembly	Rotary idler assembly (See Pp. 6.10 - 6.11)	2	RIA-KT9625
9	Part	Cam follower	40	SSCF1500

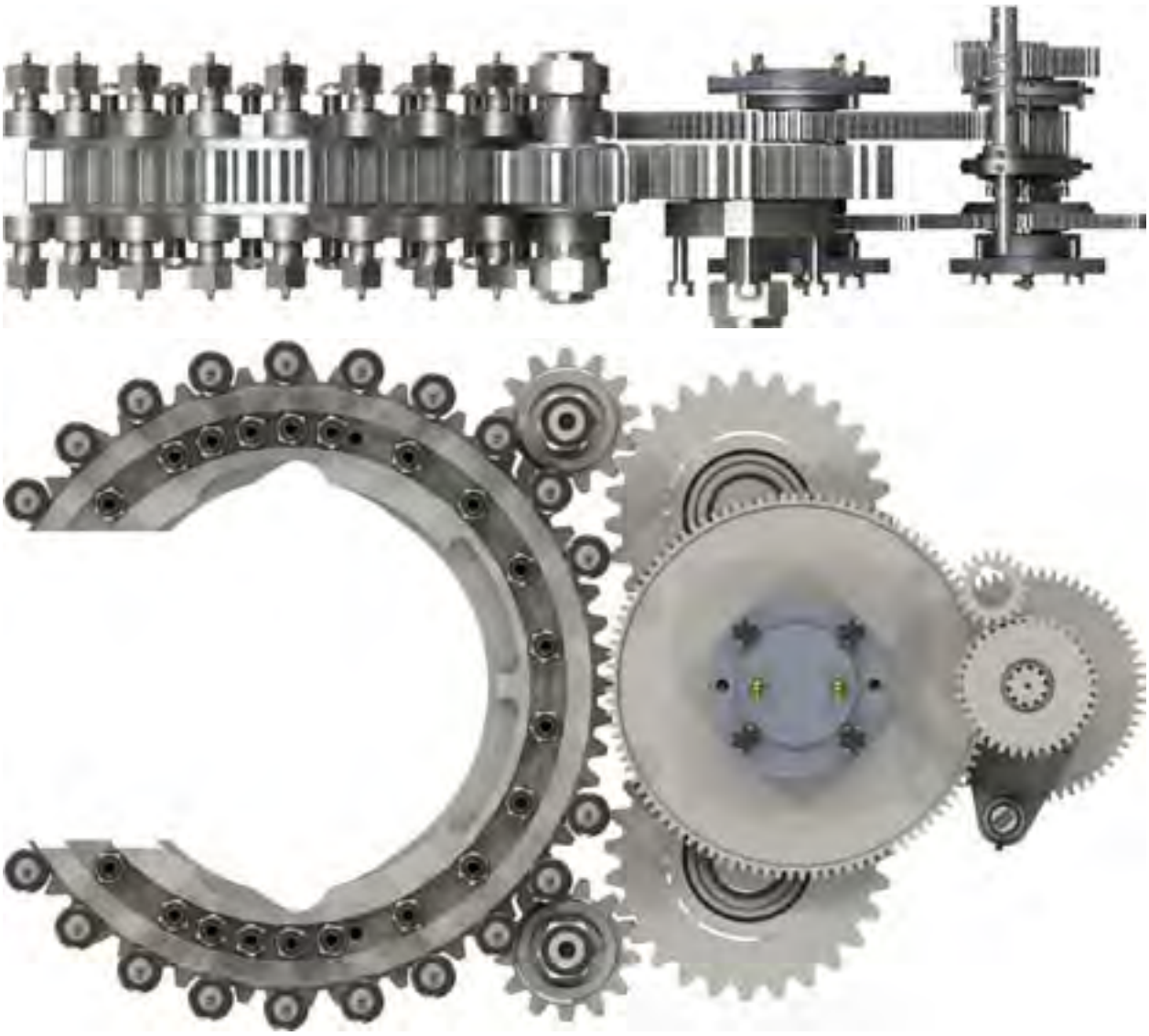

ILLUSTRATION 6.2: HD-9-⅝" GEAR TRAIN SIDE / TOP VIEWS

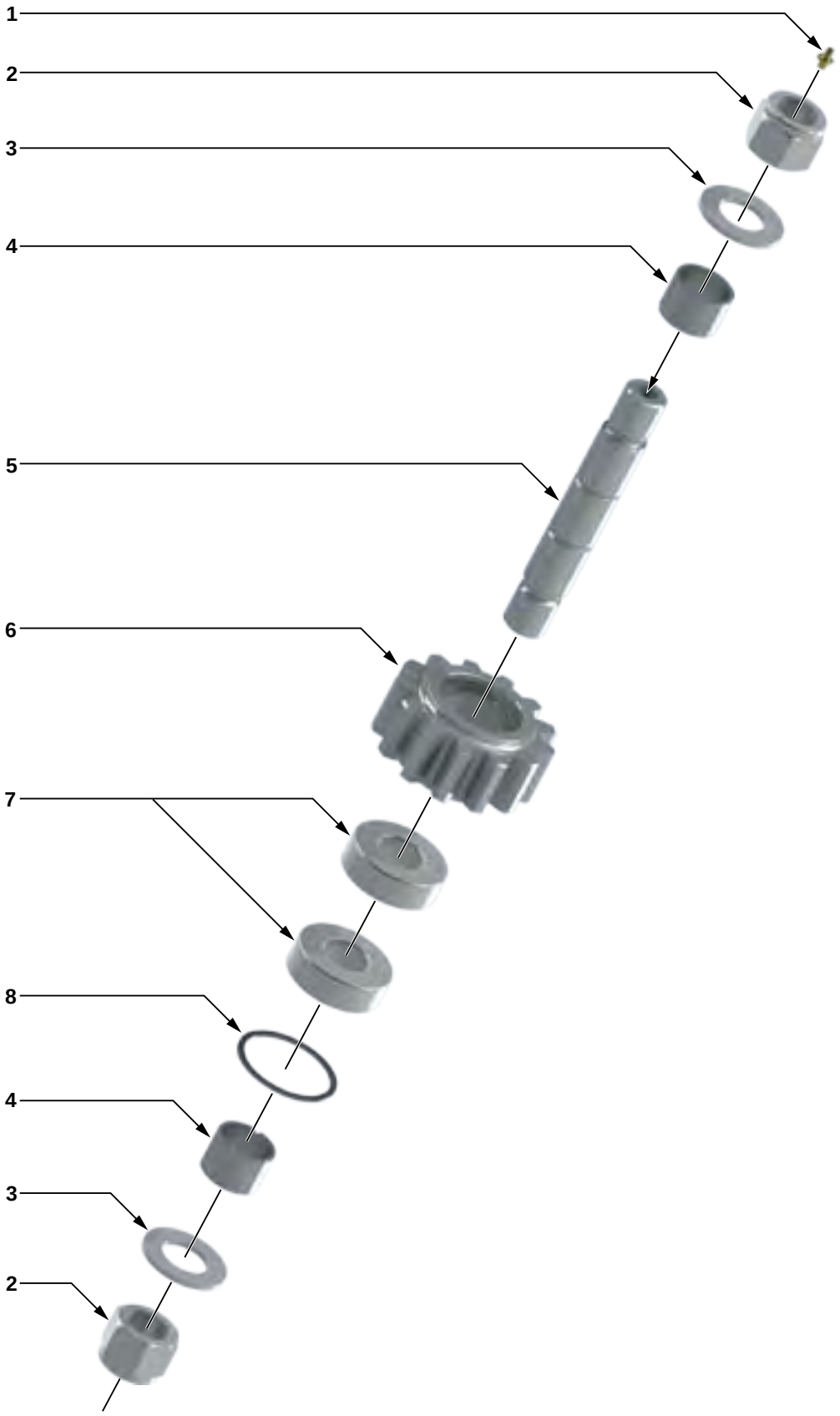

Illustration 6.3: HD-9-⅝" Rotary Idler Exploded

ILLUSTRATION 6.4: HD-9-⅝" ROTARY IDLER

Item	Type	Description	Qty	Part Number	Recommended Spares (Per Assembly)		
					Critical	One-Year	Overhaul
1	Part	¼" UNF straight grease fitting	1	02-0070		1	1
2	Part	1-1/4" UNF hex nylock nut	2	09-5702			
3	Part	1-1/4" narrow flat washer	2	02-0970			
4	Part	Rotary idler spacer	2	101-5006			
5	Part	Rotary idler shaft	1	101-5005			
6	Part	Rotary idler gear	1	AK01-102-KT			
7	Part	Cylindrical roller bearing	2	02-E0104			2
8	Part	Internal retaining ring	1	02-E0105			1

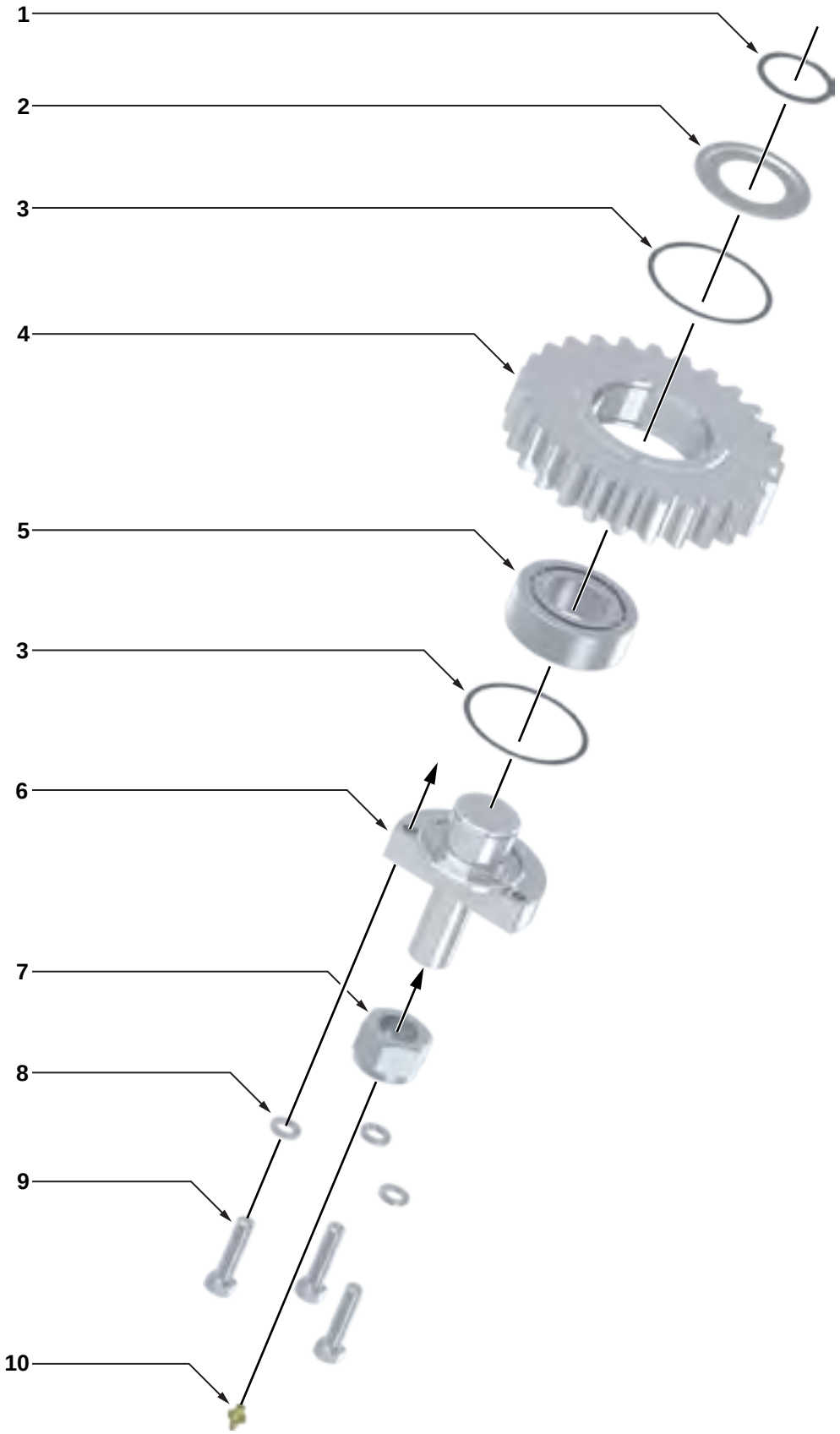

Illustration 6.5: HD-9-⅝" Pinion Idler Exploded

ILLUSTRATION 6.6: HD-9-⅝" PINION IDLER

Item	Type	Description	Qty	Part Number	Recommended Spares (Per Assembly)		
					Critical	One-Year	Overhaul
1	Part	Bearing retainer	1	02-0008			1
2	Part	Bearing seal	1	02-0010			
3	Part	Gear retainer	2	02-0009			1
4	Part	Pinion idler gear	1	AK01-122			
5	Part	Idler bearing	1	02-0075			1
6	Part	Pinion idler half shaft	1	AK01-121			
7	Part	1-½" nylock nut	1	09-5740			
8	Part	½" lock washer	3	09-5110			
9	Part	½" UNC x 2-½" hex bolt	3	09-1176			
10	Part	Grease fitting, ⅛" NPT	1	02-0005		1	1

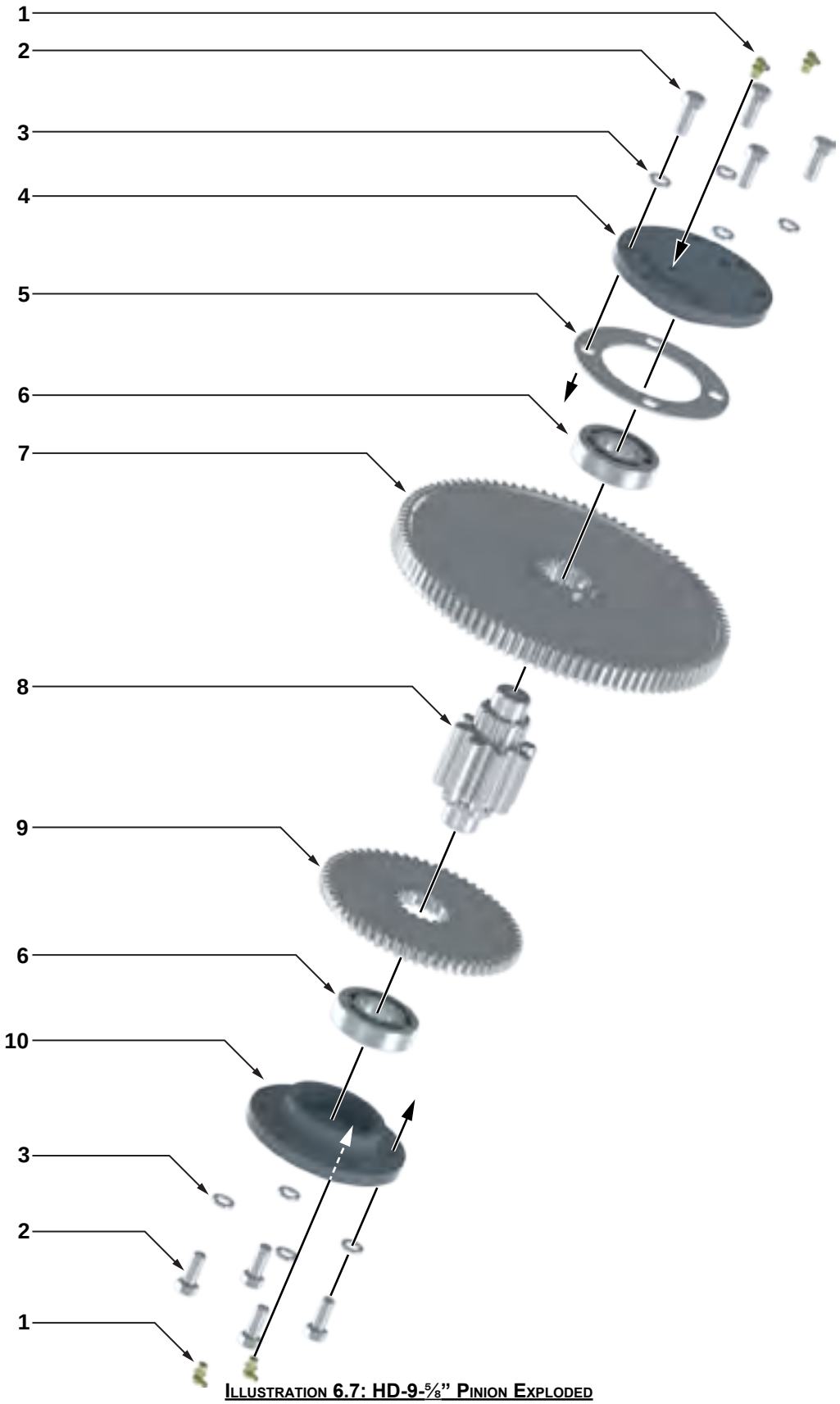

Illustration 6.7: HD-9-⅝" Pinion Exploded

ILLUSTRATION 6.8: HD-9-⅝" PINION

Item	Type	Description	Qty	Part Number	Recommended Spares (Per Assembly)		
					Critical	One-Year	Overhaul
1	Part	⅛" NPT 90° grease fitting	4	02-0093		2	4
2	Part	½" UNC x 1-½" hex bolt	8	09-1168			
3	Part	½" lock washer	8	09-5110			
4	Part	Top pinion bearing cap	1	997-D15-89			
5	Part	Pinion bearing spacer	1	1400-89A			1
6	Part	Cylindrical roller bearing	2	1234-08-01B		2	2
7	Part	Low pinion gear	1	997-A5-88			
8	Part	Pinion gear shaft	1	997-A7-86B			
9	Part	High pinion gear	1	997-A4-87B			
10	Part	Bottom pinion bearing cap	1	AK01-151			

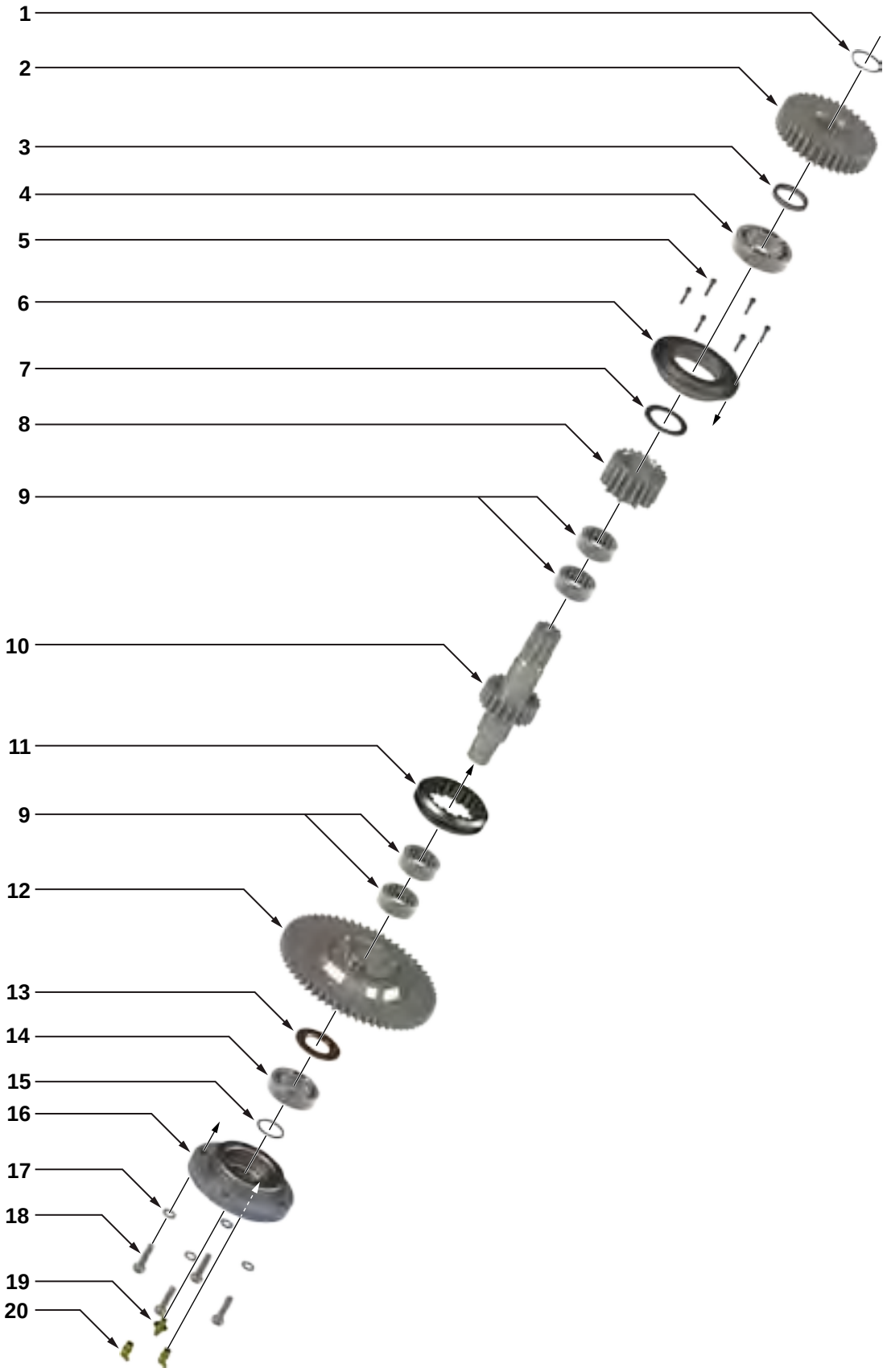

Illustration 6.9: HD-9-⅝" Clutch Exploded

ILLUSTRATION 6.10: HD-9-⅝" CLUTCH

Item	Type	Description	Qty	Part Number	Recommended Spares (Per Assembly)		
					Critical	One-Year	Overhaul
1	Part	External snap ring	1	1234-00-04		1	1
2	Part	Drive gear	1	997-HT-61	1		1
3	Part	Top clutch spacer	1	AK01-205		1	1
4	Part	Top clutch bearing	1	02-0077		1	1
5	Part	#10 x ¾" hex SHCS	6	09-0001			
6	Part	Top bearing retainer	1	AK01-203			
7	Part	Top clutch bearing spacer	1	AK01-204			1
8	Part	Low clutch gear	1	997-HT-52			1
9	Part	Needle roller bearing	4	02-1404			4
10	Part	Splined clutch shaft	1	AK01-202			1
11	Part	Shifting collar	1	997-HT-62	1		1
12	Part	High clutch gear	1	997-HT-51B			1
13	Part	Bottom clutch spacer	1	997-99			1
14	Part	Bottom clutch bearing	1	02-0076		1	1
15	Part	Clutch o-ring	1	08-1240			1
16	Part	Clutch bearing cap	1	AK01-201			
17	Part	⅜" lock washer	4	09-5106			
18	Part	⅜" UNC x 1-¼" hex bolt	4	09-1048			
19	Part	⅛" NPT 90° grease fitting	2	02-0093		1	2
20	Part	⅛" NPT grease fitting	1	02-0005		1	1

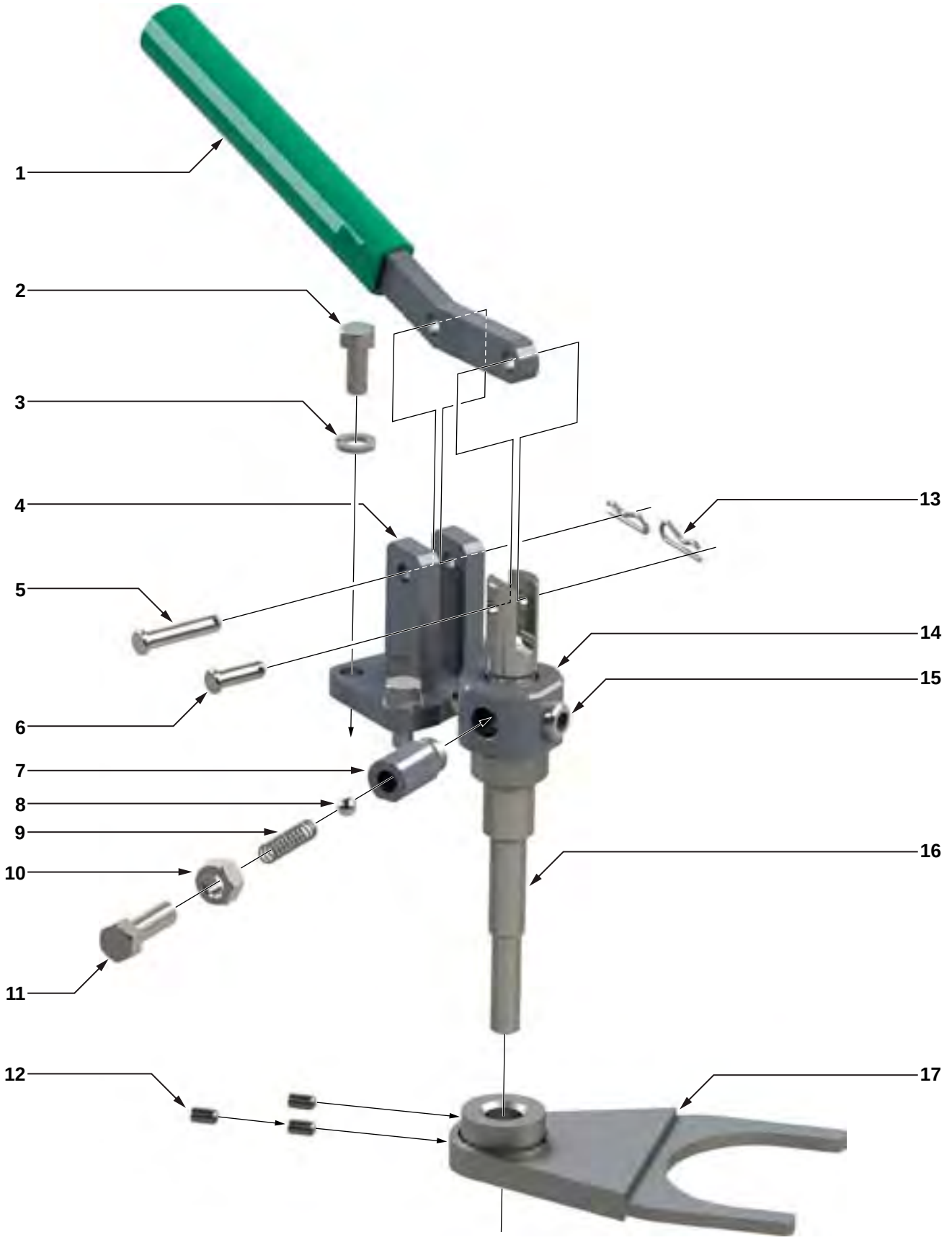

Illustration 6.11: HD-9-⅝" Shifter Exploded

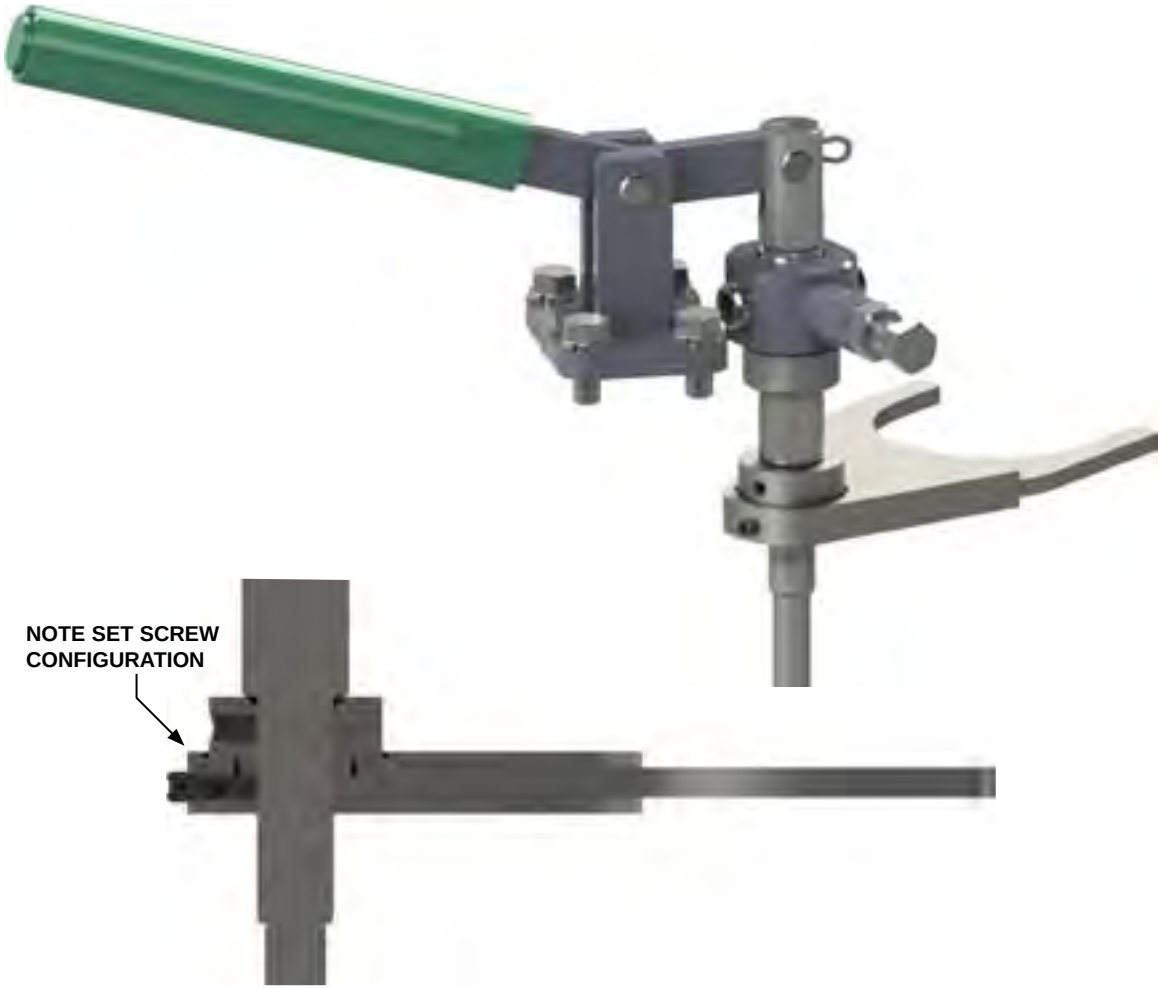

ILLUSTRATION 6.12: HD-9-⅝" SHIFTER

Item	Type	Description	Qty	Part Number	Recommended Spares (Per Assembly)		
					Critical	One-Year	Overhaul
1	Weldment	Shifting handle weldment	1	AK00-092			
2	Part	⅜" UNC x 1" hex bolt	4	09-1046			
3	Part	⅜" lock washer	4	09-5106			
4	Weldment	Shifter lug weldment (bolted)	1	101-0016			
5	Part	5/16" x 1-½" clevis pin	1	09-0256		1	1
6	Part	5/16" x 1" clevis pin	1	02-0020		1	1
7	Part	Threaded shifter detent tube	1	101-0019	1		
8	Part	Detent ball	1	02-0018		1	1
9	Part	Detent spring	1	997-0-64		1	1
10	Part	7/16" UNF hex jam nut	1	09-5508		1	1
11	Part	7/16" UNF x 1-¼" hex bolt	1	09-1608		1	1
12	Part	¼" UNC x ⅜" hex socket set screw	3	09-0107			3
13	Part	Hitch pin 0.0930" x 1-⅛"	2	02-0274		2	2
14	Part	Top shifter bushing (threaded)	1	101-0020		1	
15	Part	⅝" UNC x ⅝" hex socket set screw	3				
16	Part	Shifting shaft	1	101-5999	1		1
17	Weldment	Shifting fork	1	101-6169	1		1

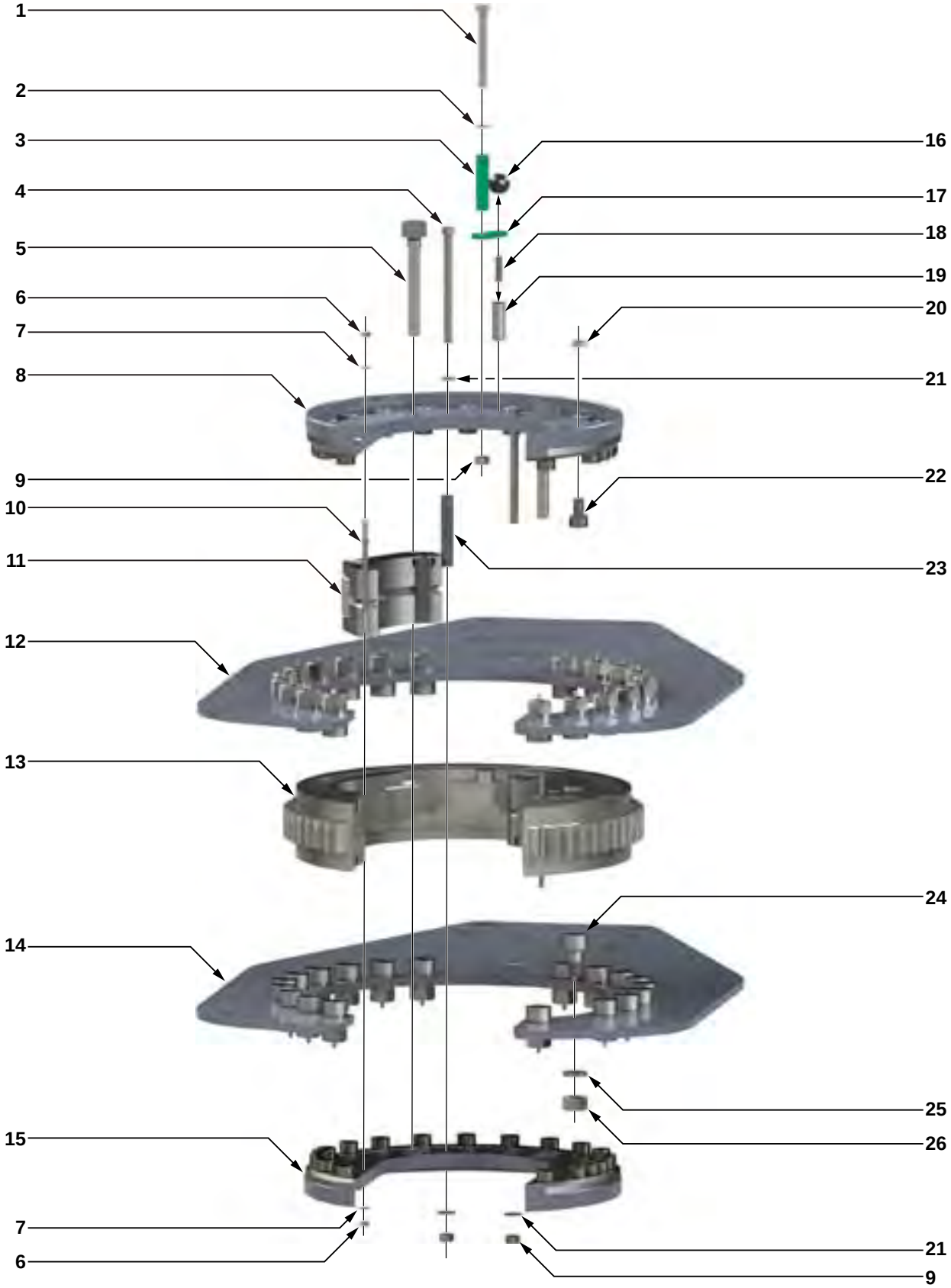

Illustration 6.13: HD-9-⅝" Cage Plate Exploded

ILLUSTRATION 6.14: HD-9-⅝" CAGE PLATE

Item	Type	Description	Qty	Part Number	Recommended Spares (Per Assembly)		
					Critical	One-Year	Overhaul
1	Part	½" UNC x 4-½" hex bolt	1	09-1184			
2	Part	½" narrow flat washer	3	09-5119			
3	Part	Backing pin spacer	1	101-4995			
4	Part	½" UNC x 6-½" hex bolt	2	09-1071			
5	Part	Jaw pivot bolt	2	AK10-056	2		2
6	Part	5/16" UNC hex nut	4	09-6016			
7	Part	5/16" lock washer	4	09-5104			
8	Part	Cage plate - TOP	1	AK20-010-KT			
9	Part	½" UNC hex nut	1	09-9124			
10	Part	Front cage plate spacer	2	AK20-031			
11	Assembly	Jaw die kit (8-⅝" shown - see Pg. 2.17)	2				
12	Part	Top Plate (shown for illustration purposes only)	1	AK07-001M-KT _TOP			
13	Part	Rotary gear	1	AK01-001-KT			
14	Part	Bottom plate (shown for illustration purposes only)	1	AK07-001M-KT _BOT			
15	Weldment	Bottom cage plate weldment	1	AK20-20W-KT			
16	Part	Backing pin knob	1	02-0017		1	
17	Part	Backing pin retainer	1	101-4040			
18	Part	⅜" UNC threaded stud	1	101-4058		1	
19	Part	Backing pin	1	101-4994	1		1
20	Part	⅝" UNF thin nylock nut	40	09-5513		8	40
21	Part	½" lock washer	3	09-5110			
22	Part	Cam follower	40	02-0016		8	40
23	Part	Cage plate spacer	2	101-4992			
24	Part	Cam follower	40	SSCF1500		8	40
25	Part	⅞" narrow flat washer	40	09-5123		8	40
26	Part	⅞" UNF nylock jam nut	40	09-5722		8	40

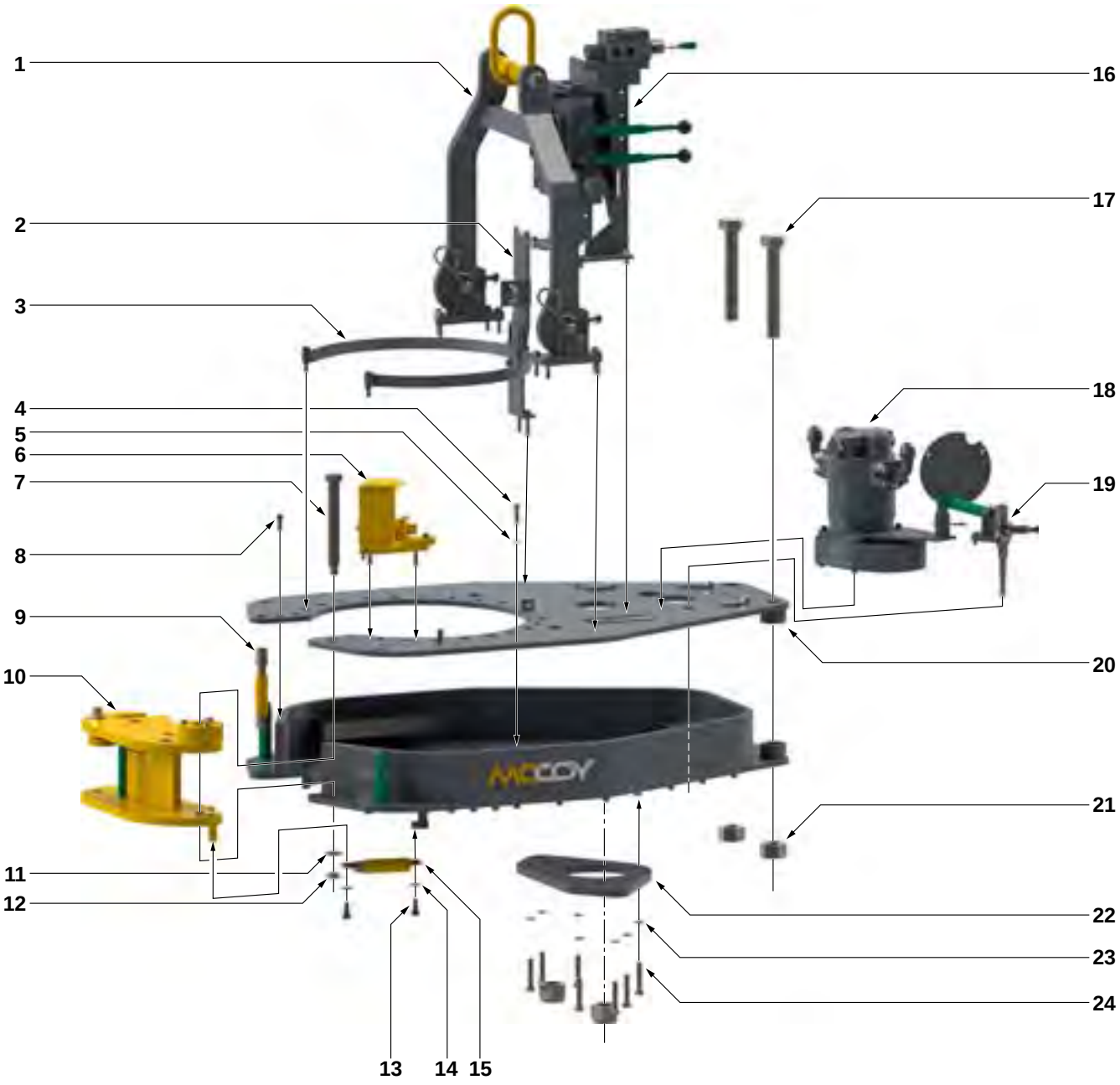

Illustration 6.15: HD-9-⅝" Body Exploded

Item	Type	Description	Qty	Part Number	Recommended Spares (Per Ass'y)		
					Critical	One-Year	Overhaul
1	Assembly	Rigid sling assembly (see Pp. 6.32 - 6.33)	1				
2	Assembly	Hydraulic tubing support assembly (see Pp. 6.24 - 6.25)	1				
3	Weldment	Lined brake band weldment (See Pp. 6.28 - 6.29)	2	101-4999			
4	Part	⅜" UNC x 1-½" hex bolt	50	09-1553			
5	Part	⅜" Lock Washer	56	09-5106			
6	Assembly	Safety door valve protector (see Pp. 6.30 - 6.31)	1				
7	Part	Door pivot pin	1	101-5034			
8	Part	⅜" UNC x 1" hex socket head cap screw	8	09-1738			
9	Part	Door post	1	09-1738			
10	Assembly	Door assembly (see Pp. 6.30 - 6.31)	1				
11	Part	¾" narrow flat washer	1	09-5018			
12	Part	¾" UNF thin nylock nut	1	09-5718			
13	Part	½" x ½" UNC shoulder bolt	4	09-0973			
14	Part	½" narrow flat washer	4	09-5010			
15	Assembly	Door stop cylinder assembly	1	101-0069			
16	Assembly	Hydraulic valve support assembly (See Pp. 6.24 - 6.25)	1				
17	Part	1-¼" x 8" hex bolt	2	09-0222			
18	Assembly	Motor & motor mount assembly (See Pp. 6.26 - 6.27)	1				
19	Assembly	Shifter assembly (See Pp. 6.18 - 6.19)	1				
20	Weldment	Top body plate weldment	1	AK07-001M-KT			
21	Part	1-¼" UNC hex nylock nut	2	09-1484			
22	Part	Stiffener plate	1	AK00-001			
23	Part	½" lock washer	7	09-5110			
24	Part	½" UNC x 2-½" hex bolt	7	09-1176			

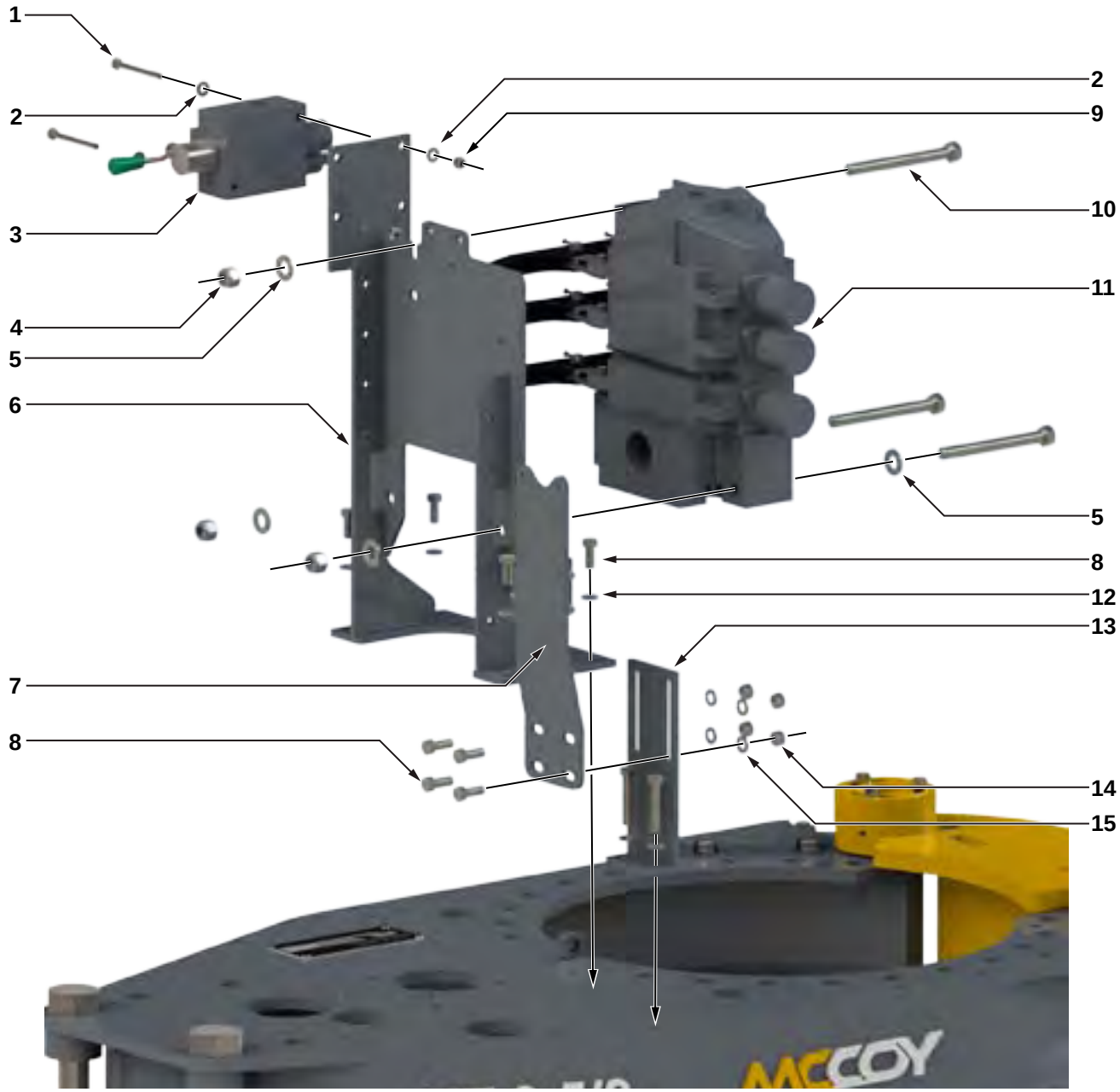

Illustration 6.16: HD-9-⅝" Hydraulic Supports Exploded

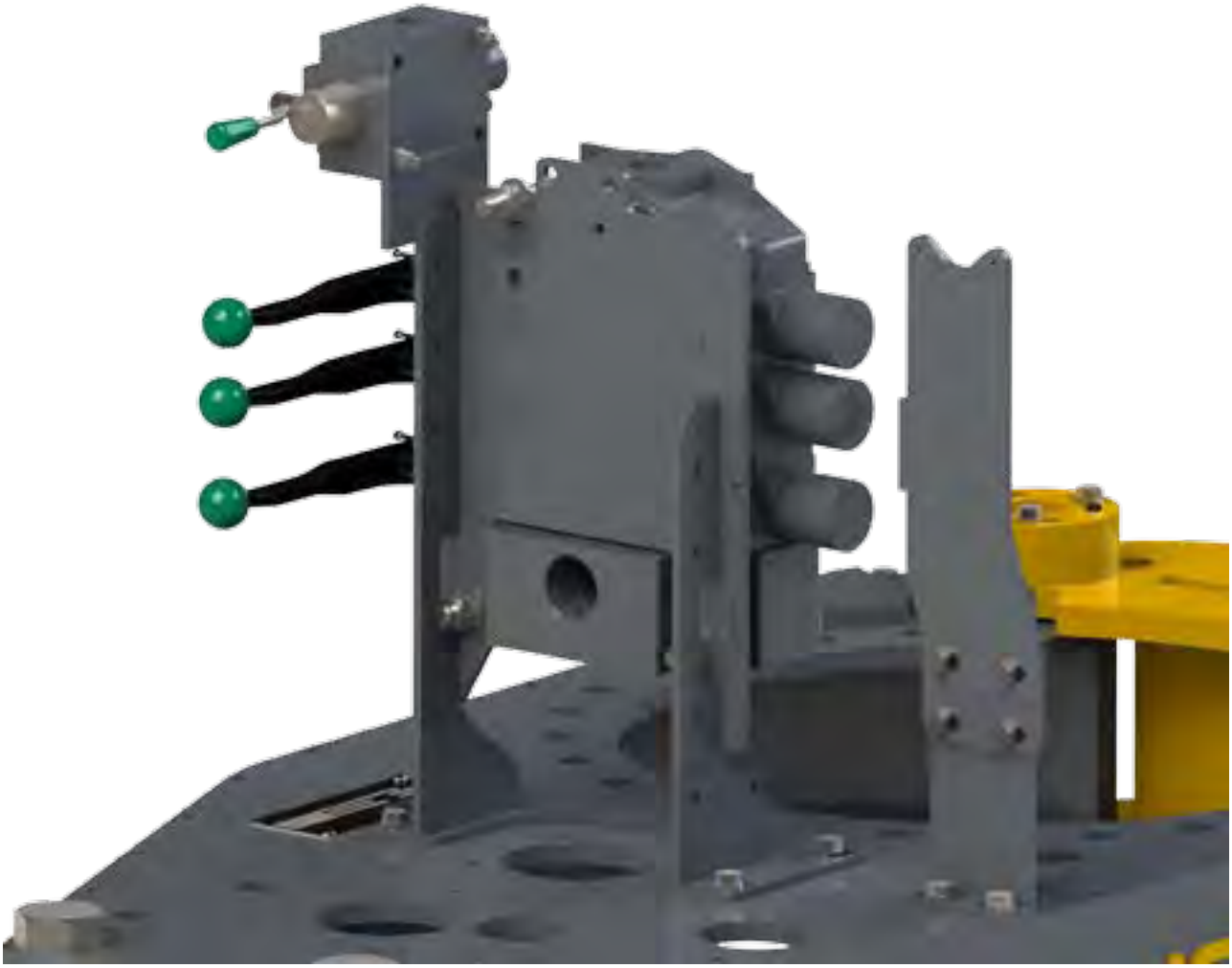

ILLUSTRATION 6.17: HD-9-⅝" HYDRAULIC SUPPORTS

Item	Type	Description	Qty	Part Number	Recommended Spares (Per Assembly)		
					Critical	One-Year	Overhaul
1	Part	¼" UNC x 2-½" hex bolt	2	09-1017			
2	Part	¼" narrow flat washer	4	09-1119			
3	Part	Motor speed control valve	1	10-9035	1		
4	Part	½" UNC nylock nut	3	09-5610			
5	Part	½" narrow flat washer	5	09-5119			
6	Weldment	Valve mount weldment	1	AK00-070B-KT			
7	Weldment	Adjustable support plate weldment	1	101-5075			
8	Part	⅜" UNC x 1" hex bolt	8	09-1046			
9	Part	¼" UNC hex nylock nut	2	09-5701			
10	Part	½" UNC x 5" hex bolt	3	09-1186			
11	Assembly	Hydraulic valve assembly - DVA35	1				
12	Part	⅜" helical lock washer	4	09-5106			
13	Weldment	Inlet coupling support weldment	1	101-1138			
14	Part	⅜" UNC nylock nut	4	09-5607			
15	Part	⅜" narrow flat washer	4	09-5124			

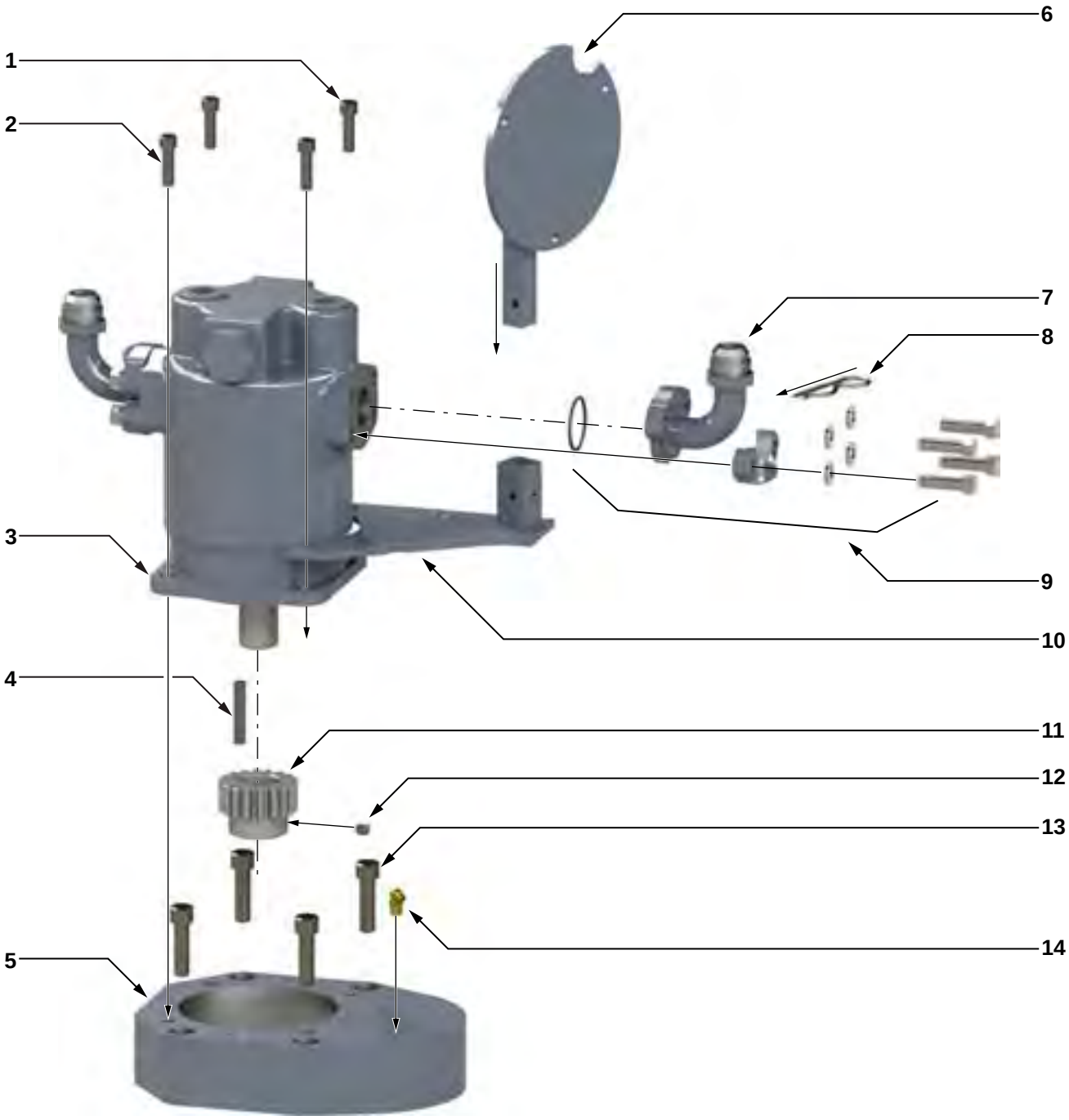

ILLUSTRATION 6.18: HD-9-⅝" MOTOR & MOUNT EXPLODED

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ILLUSTRATION 6.19: HD-9-⅝" MOTOR & MOUNT

Item	Type	Description	Qty	Part Number	Recommended Spares (Per Assembly)		
					Critical	One-Year	Overhaul
1	Part	½" UNC x 1-½" hex socket head cap screw	2	09-2170			
2	Part	½" UNC x 1-¼" hex socket head cap screw	2	09-2168			
3	Part	Two-speed hydraulic motor	1	87-0008	1		
4	Part	5/16" x 5/16" x 2" square gear key	1				
5	Part	Motor mount	1	1064-C8-150			
6	Weldment	Torque gauge mount weldment	1	1500-09-03A			
7	Part	#20 (1-¼")/JIC 1" flange elbow	2	02-9216			
8	Part	0.148" x 2.938" hitch pin	1				
9	Part	#20 (1-¼") split flange kit	2	02-9217			
	Part	O-Ring	1				
	Part	#20 (1-¼") split flange	2				
	Part	7/16" lock washer	4				
	Part	7/16" UNC x 1-½" hex bolt	4				
10	Weldment	Torque gauge holder weldment	1	1500-09-04A			
11	Part	Motor gear	1	997-A10-149	1		1
12	Part	⅜" UNC x ⅜" hex socket set screw	2	09-0106	2		2
13	Part	½" UNC x 2" hex socket head cap screw	4	09-0234			
14	Part	⅛" NPT 90° grease fitting	1	02-0093		1	1
15	Kit	Motor seal kit		87-7110		1	1

Illustration 6.20: HD-9-⅝" Brake Bands Exploded

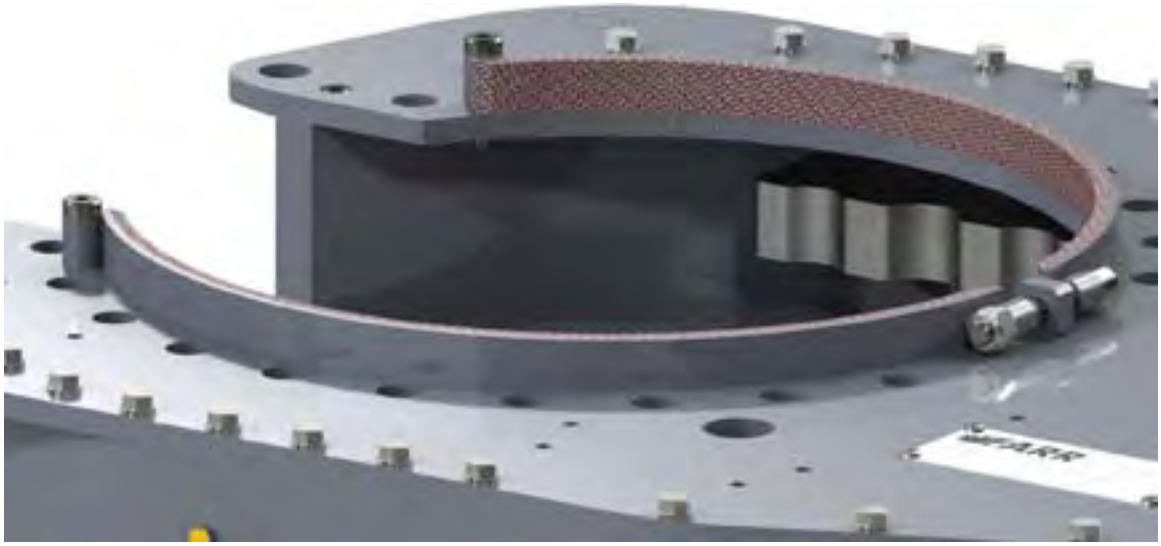


ILLUSTRATION 6.21: HD-9-⅝" BRAKE BANDS

Item	Type	Description	Qty	Part Number	Recommended Spares (Per Assembly)		
					Critical	One-Year	Overhaul
1	Part	½" x 1-½" hex socket head shoulder screw	4	09-1113		2	
2	Weldment	Lined Brake Band Weldment	2	101-4999	4		4
3	Part	½" UNC Nylock Nut	2	09-5610			
4	Part	½" UNC x 3-¾" Hex Socket Head Cap screw	2	25-6001		1	

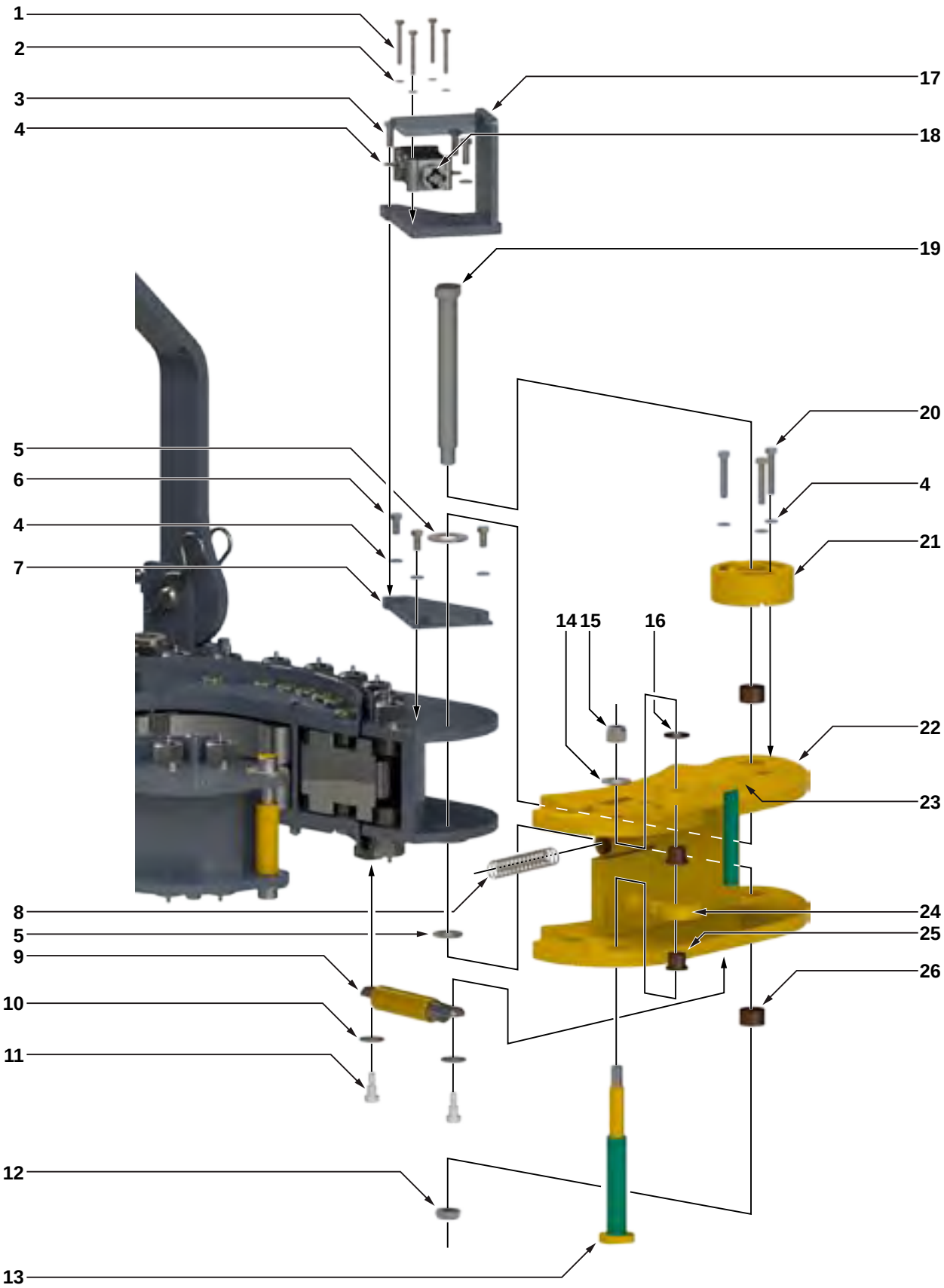


Illustration 6.22: HD-9-⅝" Door Assembly Exploded

ILLUSTRATION 6.23: HD-9-⅝" DOOR ASSEMBLY

Item	Type	Description	Qty	Part Number	Recommended Spares (Per Ass'y)		
					Critical	One-Year	Overhaul
1	Part	¼" UNC x 2" hex bolt	4	09-1015			
2	Part	¼" lock washer	4	09-5102			
3	Part	⅜" UNC x 1" hex bolt	3	09-1046			
4	Part	⅜" lock washer	9	09-5106			
5	Part	1" narrow flat washer	2	09-5120			
6	Part	⅜" UNC x ¾" hex bolt	3	09-1044			
7	Part	Safety door valve mounting plate	1	101-5592			
8	Part	Door latch spring	1	997-13D		1	1
9	Assembly	Door spring cylinder	1	101-0069	1		1
	Weldment	Door cylinder barrel weldment	1	997-12-01			
	Part	Door cylinder piston	1	997-12-02			
	Part	Door cylinder spring	1	997-13			
10	Part	½" regular flat washer	2	09-5010			
11	Part	½" x ½" hex socket UNC shoulder bolt	2	02-0973			
12	Part	¾" UNF thin nylock nut	1	09-5718			
13	Part	Door lock shaft	1	101-5249			
14	Part	3/4" narrow flat washer	1	09-5013			
15	Part	5/8" UNC hex nylock nut	1	09-5614			
16	Part	Door latch thrust washer	1	02-E0125		1	1
17	Weldment	Safety door valve mount / protector weldment	1	101-5594			
18	Part	Safety door valve	1	02-E0190	1		
19	Part	Door pivot post (single door)	1	101-5034			
20	Part	3/8" UNC x 2" hex bolt	3	09-1054			
21	Part	Safety door cam	1	101-5598	1		
22	Weldment	Door weldment	1	AK12-702B-KT-SINGLE			
23	Weldment	Door latch handle weldment	1	101-5250			
24	Part	Door latch	1	101-5246	1		
25	Part	Door latch bushing	2	02-E0124		2	2
26	Part	Door bushing	2	02-E0126		2	2

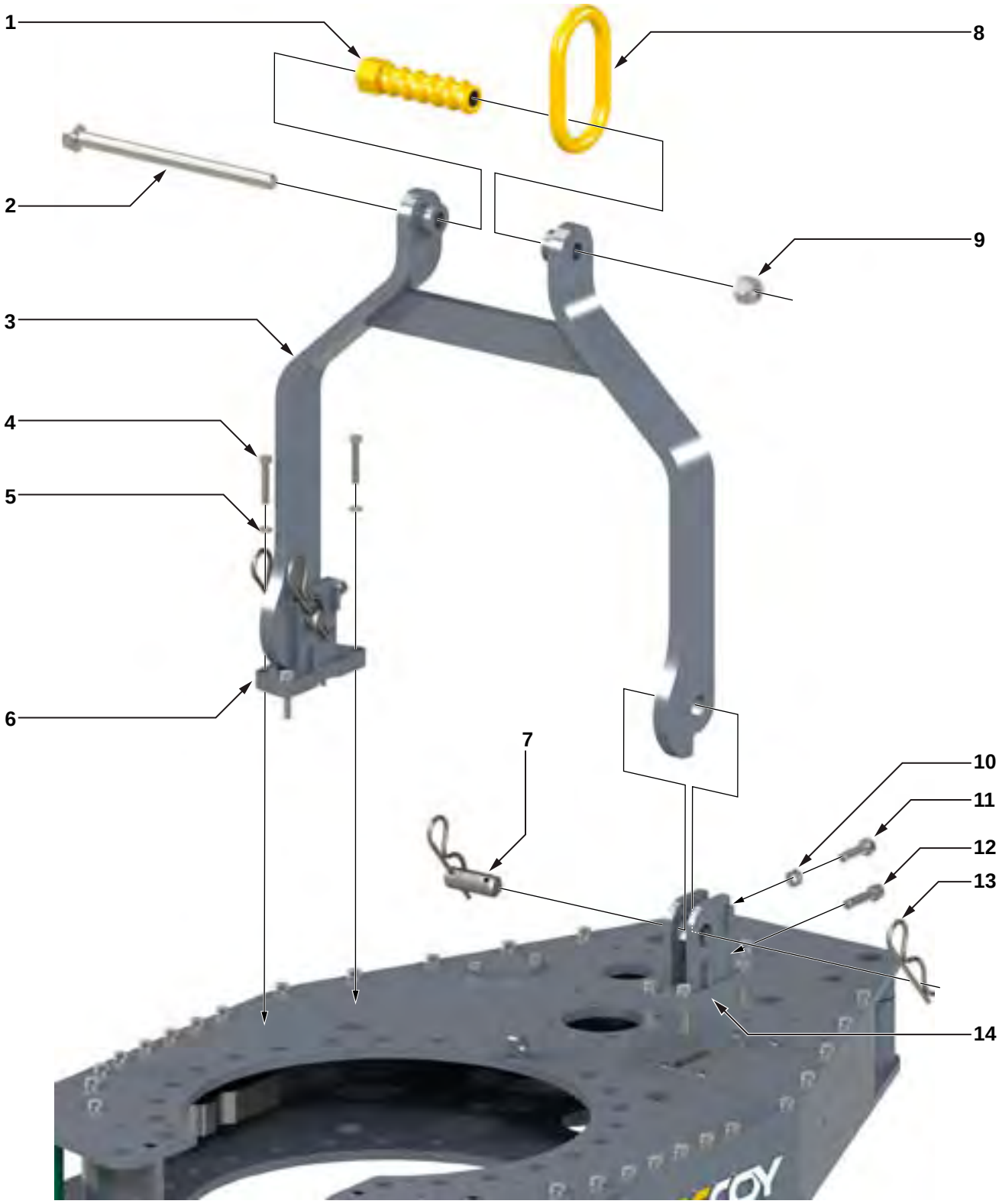


Illustration 6.24: HD-9-⅝" Rigid Sling Exploded

ILLUSTRATION 6.25: HD-9-⅝" RIGID SLING ASSEMBLY

Item	Type	Description	Qty	Part Number	Recommended Spares (Per Ass'y)		
					Critical	One-Year	Overhaul
1	Part	Rigid sling adjustment helix	1	1053-1-H			1
2	Part	¾" UNC x 9" hex bolt	1	09-1322	1		1
3	Weldment	Rigid sling weldment	1	AK06-000B-KT			
4	Part	⅜" UNC x 2" hex bolt	8	09-1046			
5	Part	⅜" helical lock washer	8	09-5106			
6	Weldment	RH rigid sling bracket	1	101-1245			
7	Part	Rigid sling pin	2	AK00-056	2		2
8	Part	Lifting link	1	02-0516	1		1
9	Part	¾" UNC nylock nut	1	1429-39-02	1		1
10	Part	½" UNC hex jam nut	2	09-5810			
11	Part	½" UNC x 1-¾" hex bolt	2	09-1172			
12	Part	½" UNC x 2" hex socket head cap screw	2	09-0234			
13	Part	3/16" hitch pin	2	02-0028	2		4
14	Weldment	LH rigid sling bracket	1	101-1244			

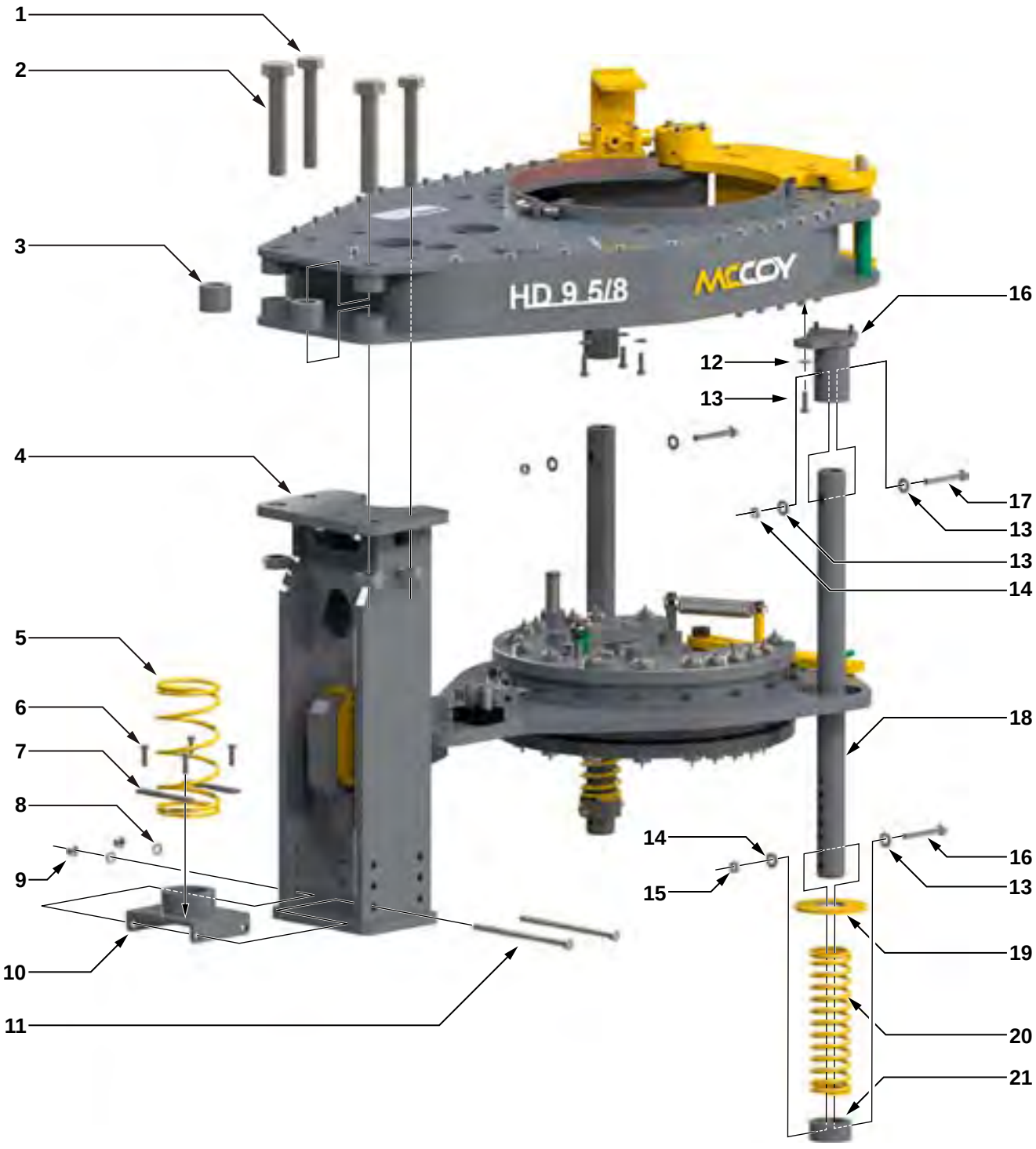


Illustration 6.26: HD-9-⅝" Leg Assemblies Exploded

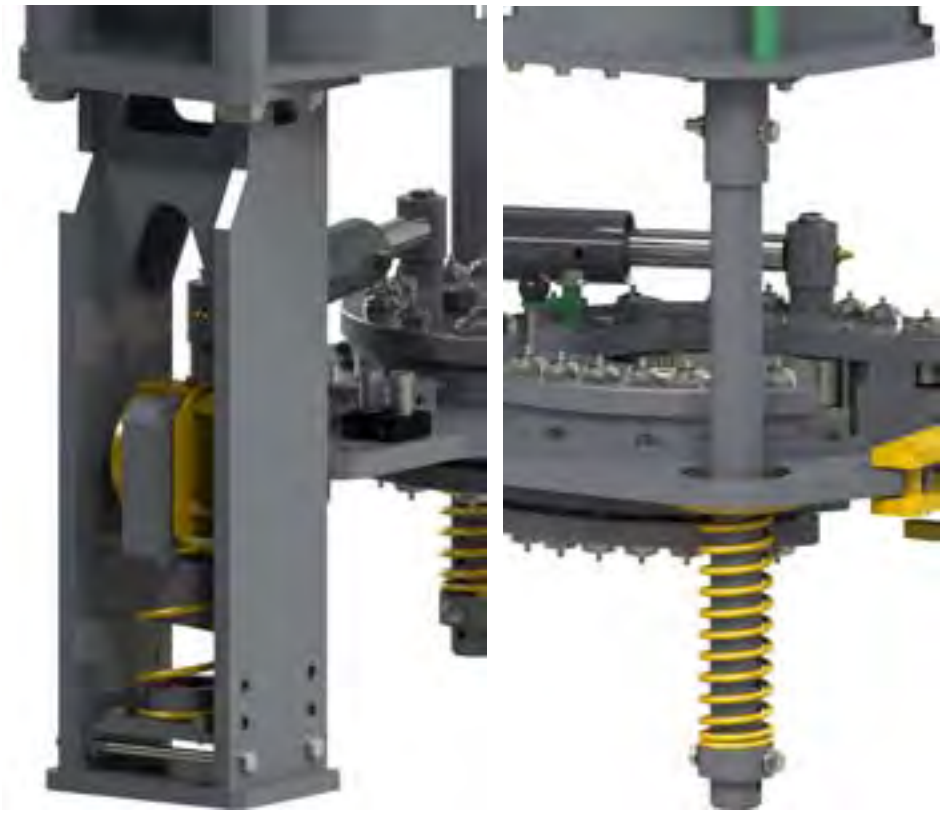


ILLUSTRATION 6.27: HD-9-⅝" LEG ASSEMBLIES

Item	Type	Description	Qty	Part Number	Recommended Spares (Per Ass'y)		
					Critical	One-Year	Overhaul
1	Part	1" UNC x 7" heavy hex bolt	2	09-9165			
2	Part	1-¼" x 7" heavy hex bolt	2	09-9155			
3	Part	Rear spacer lug	2	101-5734			
4	Weldment	Rear leg weldment	1	101-5098			
5	Part	Rear leg spring	1	02-E0163		1	
6	Part	⅜" UNC x ¾" hex bolt	4	09-1044			
7	Part	Rear leg spring clamp	2	AK06-504			
8	Part	½" lock washer	2	09-5110			
9	Part	½" UNC hex nut	2	09-9124			
10	Weldment	Rear leg spring mount weldment	1	AK06-550			
11	Part	½" UNC x 9" hex bolt	2	09-1202			
12	Part	⅜" lock washer	6	09-5106			
13	Part	⅜" UNC x 1-¼" hex bolt	6	09-1048			
14	Part	½" narrow flat washer	8	09-5119			
15	Part	½" UNC hex nylock nut	8	09-5610			
16	Weldment	Leg mount weldment (LH)	1	101-5100			
	Weldment	Leg mount weldment (RH)	1	101-5096			
17	Part	½" UNC x 3-½" hex bolt	4	09-1177			
18	Weldment	Front leg tube weldment	2	101-2369			
19	Part	Front leg washers	2	AK06-603		1	
20	Part	Front leg spring	2	AK06-606		1	
21	Part	Bottom leg collar	2	AK06-604		1	

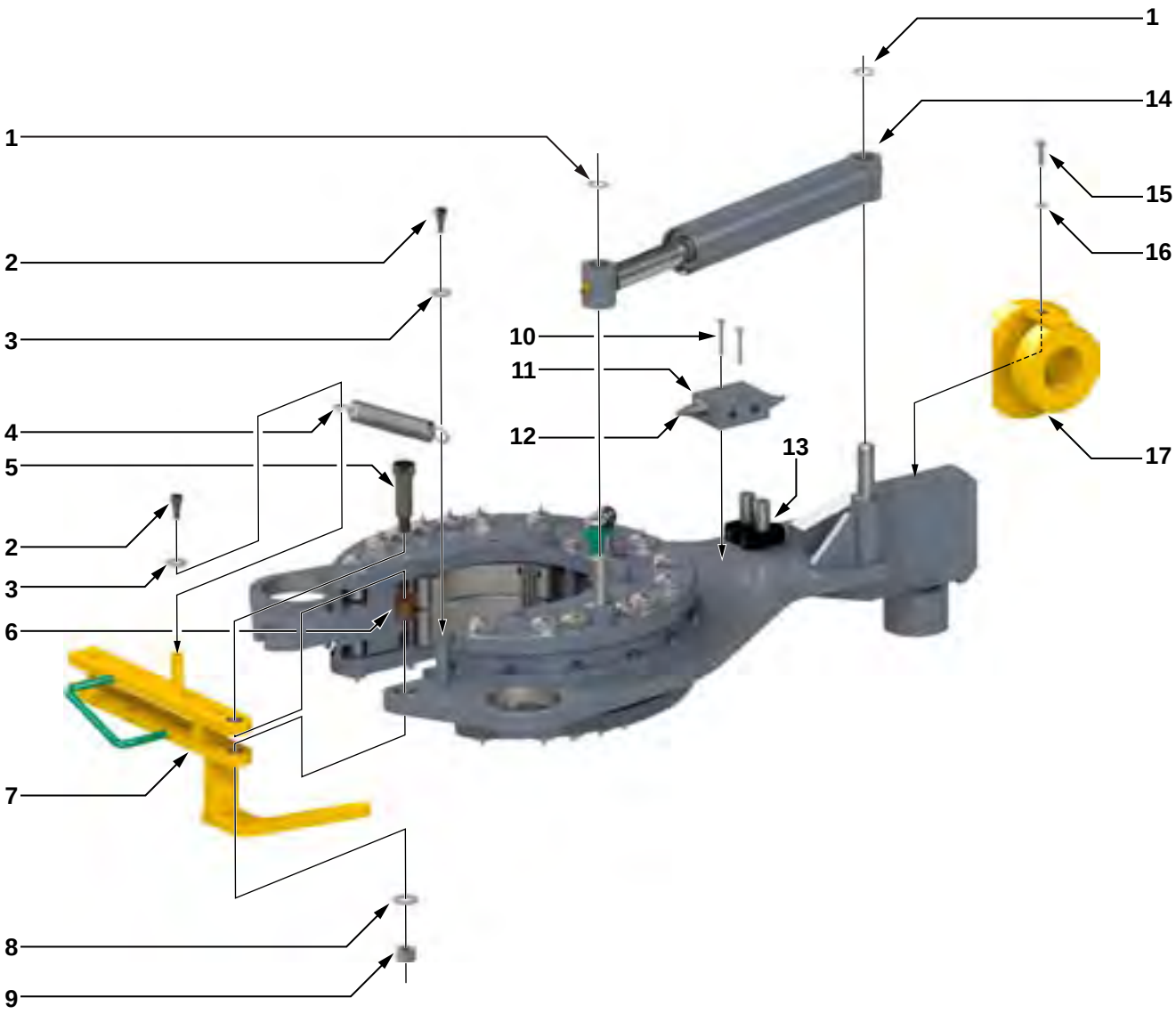


Illustration 6.26: HD-9-⅝" Backup Body Exploded

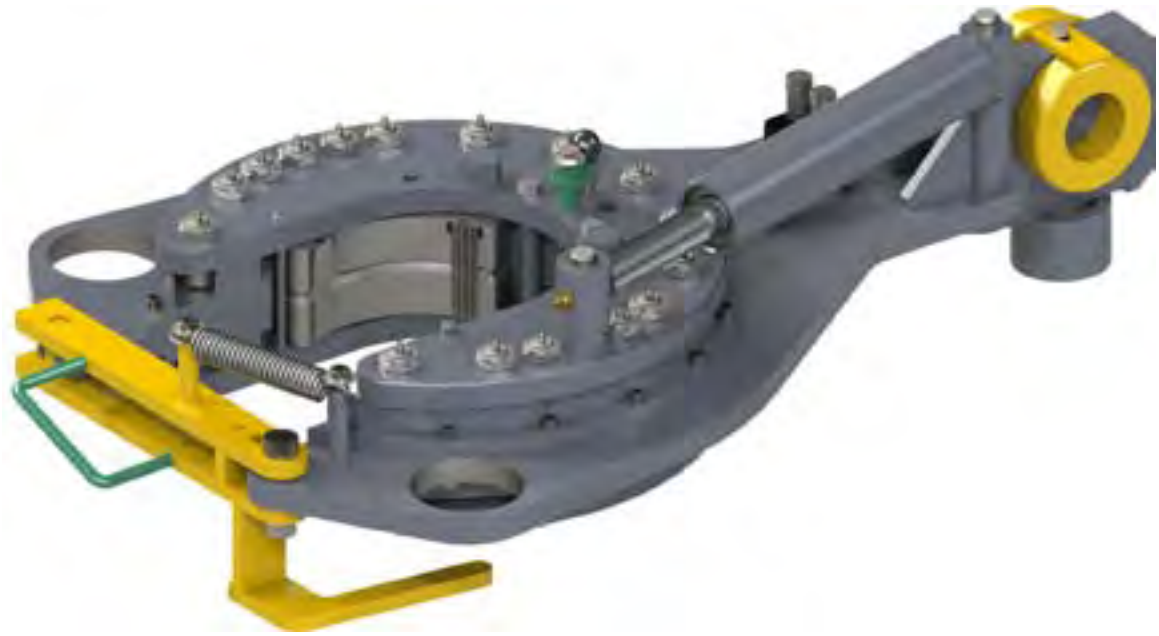


ILLUSTRATION 6.27: HD-9-⅝" BACKUP BODY

Item	Type	Description	Qty	Part Number	Recommended Spares (Per Ass'y)		
					Critical	One-Year	Overhaul
1	Part	1" external retaining ring	2	02-0697		2	
2	Part	½" x ½" hex socket UNC shoulder bolt	2	02-0973			
3	Part	½" regular flat washer	2	09-5010			
4	Part	Door spring	1	02-E0103		1	1
5	Part	Door pivot bolt	1	02-E0101		1	1
6	Part	Bushing	1	02-E0102		1	1
7	Weldment	Door weldment	1	101-4983			
8	Part	¾" narrow flat washer	1	09-5013		1	1
9	Part	¾" UNC nylock nut	1	1429-39-02		1	1
10	Part	¼" UNC x 2" hex bolt	2	09-1015			
11	Part	Relief valve body	1	08-1801			
12	Part	Valve cartridge	2	08-1053	1		
13	Part	⅜" NPT manual valve	2	08-9064			
14	Part	Clamp cylinder assembly	1	1200131			
15	Part	⅜" lock washer	1	09-5106			
16	Part	⅜" UNC x 1-¼" hex bolt	1	09-1048			
17	Weldment	Compression load cell holder	1	01-9116B			

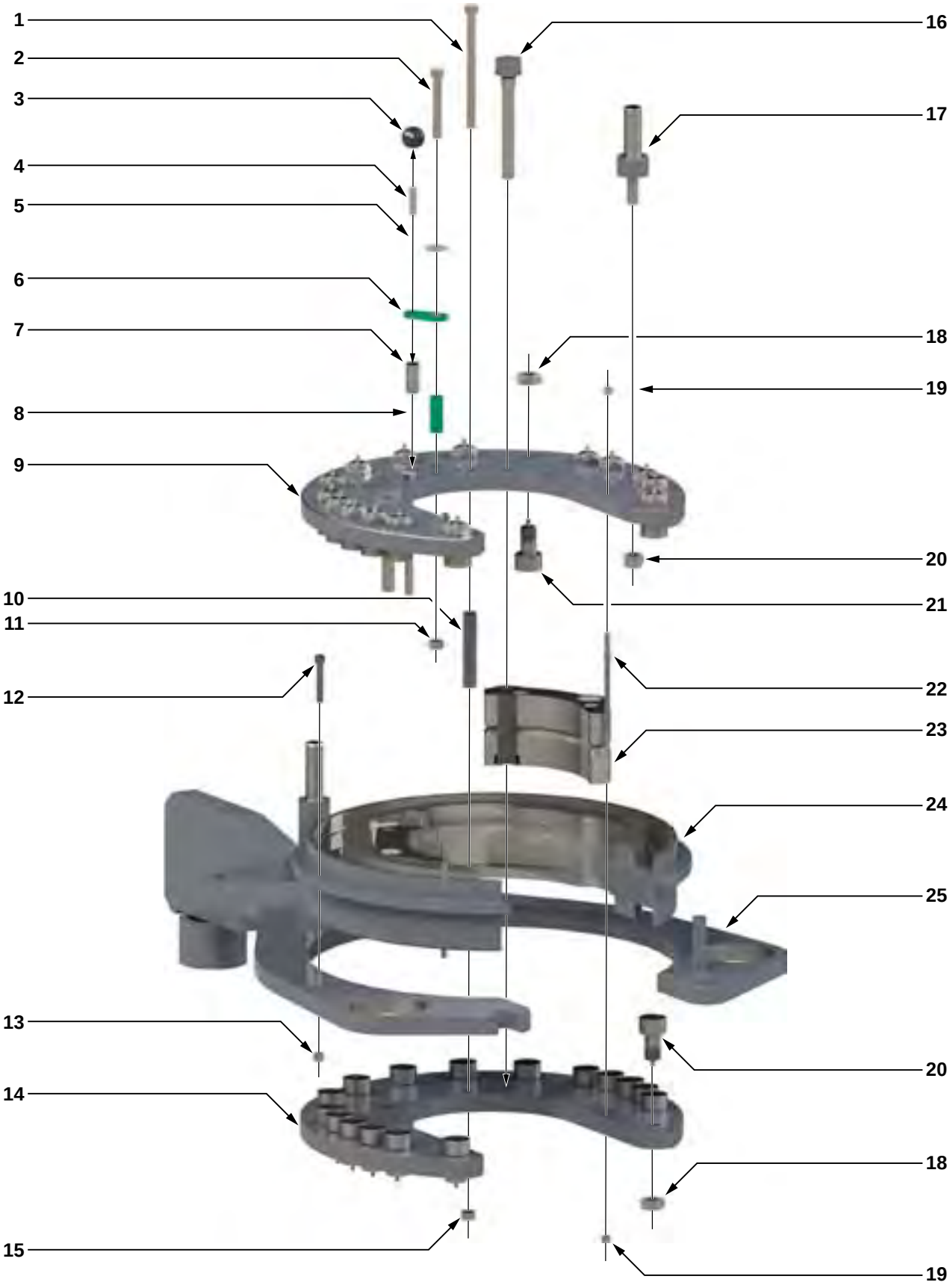
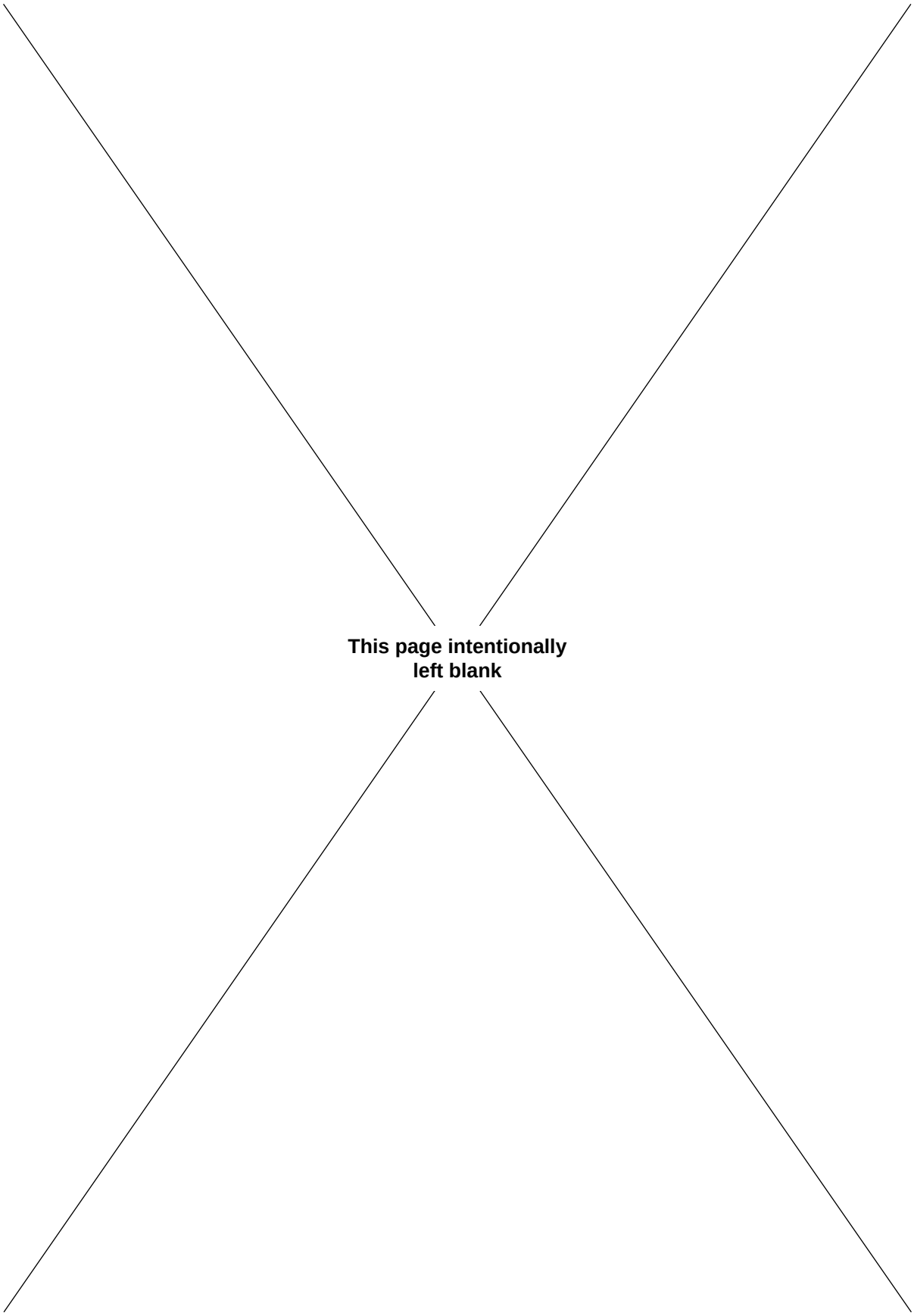


Illustration 6.26: HD-9-⅝" Backup Clamp Section Exploded

Item	Type	Description	Qty	Part Number	Recommended Spares (Per Ass'y)		
					Critical	One-Year	Overhaul
1	Part	½" UNC X 6-½" Hex Bolt	2	09-1192			
2	Part	½" UNC X 3-½" Hex Bolt	1	09-1177			
3	Part	Backing Pin Knob	1	02-0017		1	
4	Part	⅜" UNC Threaded Stud	1	101-4058		1	
5	Part	½" Narrow Flat washer	1	09-5119			
6	Part	Backing Pin Retainer	1	101-4040			
7	Part	Backing Pin	1	101-4039	1		1
8	Part	Backing Pin Spacer	1	101-4038			
9	Part	Cage Plate - TOP	1	AK10-051-KT			
10	Part	Cage Plate Spacer	2	101-4992			
11	Part	½" UNC Hex Nylock Nut	1	09-5610			
12	Part	⅜" UNC x 2-1/4" Hex Socket Head Cap Screw	15	02-0974			
13	Part	⅜" UNC Hex Nylock Nut	15	09-5607			
14	Part	Cage plate - BOTTOM	1	AK10-052-KT			
15	Part	½" UNC Thin Nylock Nut	2	09-5610S			
16	Part	Jaw Pivot Bolt	2	AK10-056	2		2
17	Part	Clamp Cylinder Mount (Front)	1	AK10-053			
18	Part	⅞" UNF Thin Hex Nylock Nuts	32	09-5721			
19	Part	⅜" UNC Hex Nylock Nut	4	09-5607			
20	Part	⅝" UNC Hex Nylock Nut	1	09-5614			
21	Part	Cam Follower	32	SSCF-1500		8	32
22	Part	Front Cage Plate Spacer	2	AK20-031			
23	Assembly	Jaw Die Kit (5-½" shown - see Pg. 2.17)	2				
24	Part	Backup Cam Ring	1	AK10-001			
25	Weldment	Backup Body Weldment	1	AK10-100-KT			



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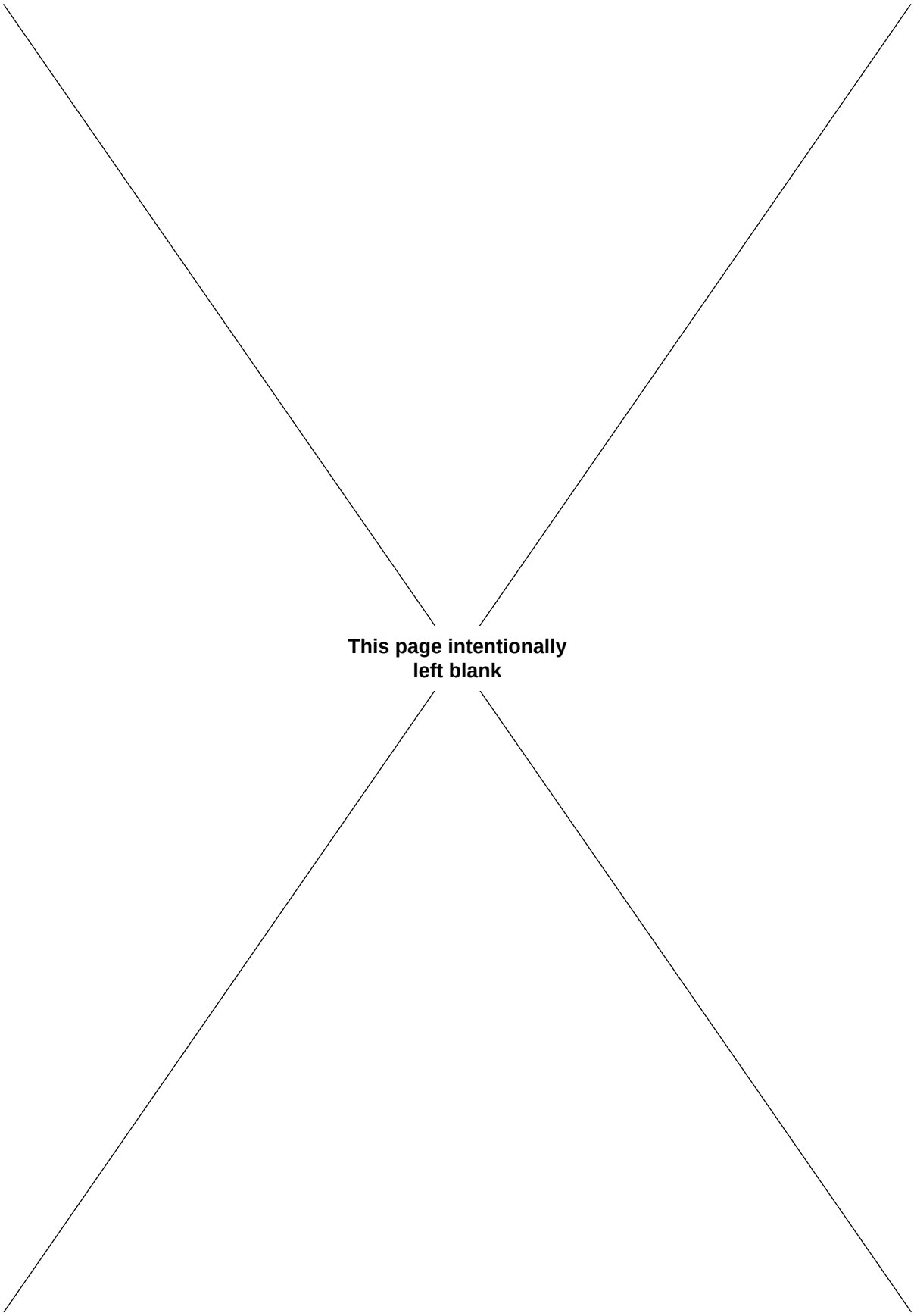
Section 7: Torque Measurement



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7.A BASIC TORQUE MEASUREMENT

Basic torque measurements are performed using a simple hydraulic measurement system. A hydraulic load cell connects to a calibrated torque gauge through a reinforced flexible hydraulic hose. The torque gauge is factory-calibrated to display accurate torque measurements for a tong or tong and backup assembly with a particular arm length. The arm length is a measurement from the centre of the pipe or casing to the centre of the force being applied to the load cell.

Two load cell options are available. A tension load cell is typically used with a suspended stand-alone tong. This application requires that the load cell be attached to the rear of the tong as part of the restraint line that opposes the force generated when the tong makes up or breaks out a joint. A compression load cell is used in a tong and backup assembly, and is typically located on the rear of the backup between the backup and a stationary frame. The load cell must be located in the centre of the compression force vector generated between the backup and the frame.

Hydraulic force generated by a load cell is transmitted to the torque gauge via a reinforced flexible hydraulic line. The hydraulic force is displayed as torque in units of Ft.-Lbs. The torque gauge has a red “peak torque” indicator that tracks with the torque gauge needle to the point of highest torque, and remains at the point of highest torque until manually reset. Note that every model of tong and tong and backup assembly has a unique arm length, and the torque gauge must be calibrated for that arm length. Torque gauges that are not calibrated for the arm length of the tool in service will not display correct torque. To ensure correct torque measurement, ensure the arm length or “handle” as displayed on your torque gauge matches the arm length of the tool in service as listed on the specifications page of the technical manual.

The images on this page are for illustration purposes only and may not accurately represent the torque gauge and load cell that have been supplied with your equipment.

THE IMAGES DISPLAYED ARE SUPPLIED FOR ILLUSTRATION PURPOSES ONLY

ILLUSTRATION 7.A.1: TORQUE GAUGE (FOR ILLUSTRATION PURPOSES ONLY)

ILLUSTRATION 7.A.2: TENSION LOAD CELL

ILLUSTRATION 7.A.3: COMPRESSION LOAD CELL

Torque gauges and load cells are supplied as a matched calibrated pair. Substituting one or the other will render the calibration inaccurate even if the actual model numbers appear to be identical. The serial numbers of matching load cell and torque gauges are clearly identified on the calibration certificate. Should you suspect the accuracy of your torque measurements, or wish to replace either component the pair should be returned to the factory for re-calibration before placing into service.

TORQUE GAUGES AND LOAD CELLS ARE FACTORY-SUPPLIED SUPPLIED AS MATCHED CALIBRATED PAIRS. IF REPLACING EITHER COMPONENT THE LOAD CELL AND TORQUE GAUGE MUST BE RETURNED TO THE FACTORY FOR RE-CALIBRATION BEFORE PLACED INTO SERVICE.

7.A BASIC TORQUE MEASUREMENT (Continued:)

The images on the preceding page are for illustration purposes only and may not accurately represent the torque gauge and load cell that have been supplied with your equipment. Please note that the parts listed in the following table are correct for accurate torque measurement while using the equipment for which this manual is supplied.

THE TORQUE GAUGE USED IS FULLY DEPENDANT UPON THE ARM LENGTH AND TORQUE RANGE OF THE EQUIPMENT IN USE. THE PART NUMBERS LISTED IN THE FOLLOWING TABLE ARE CORRECT FOR ACCURATELY MEASURING TORQUE USING THE EQUIPMENT FOR WHICH THIS MANUAL IS SUPPLIED.

Item	Type	Description	Qty	Part Number
	Assembly	28" Arm - 30K Torque Gauge / Compression Load Cell Assembly	1	10-0021C
1	Part	28" Arm 30,000 Lbs.-Ft Torque Gauge	1	10-0021G
2	Part	8 in^2 Compression Load Cell	1	10-0008C
3	Part	Hydraulic Hose	1	02-0069
4	Part	Torque Gauge Flange	1	997-D7-5

Compression Load Cell, 8 in²					
Item	Type	Description	Item	Type	Description
A	Part	5/16" UNC x 1" Hex Socket Head Cap Screw	E	Part	Diaphragm
B	Part	Load Plate	F	Part	Diaphragm Casing
C	Part	5/16" UNC x 3/4" Hex Socket Head Cap Screw	G	Part	Street Elbow
D	Part	Retainer Ring	H	Part	1/4" NPT Brass Plug

This is the standard hydraulic compression load cell supplied by McCoy Drilling & Completions | Farr. Contact our sales department for information about optional application-specific compression load cells.

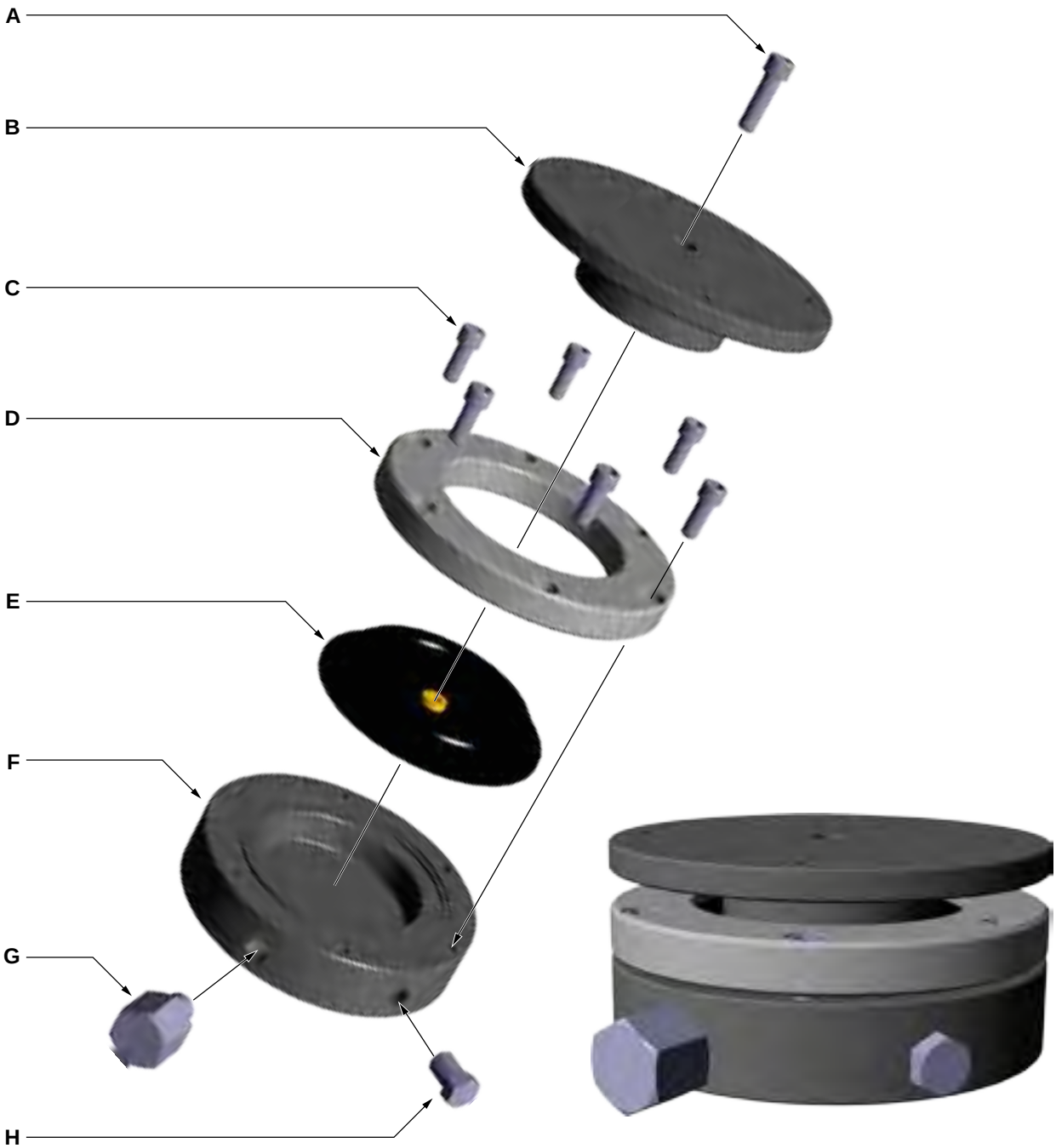
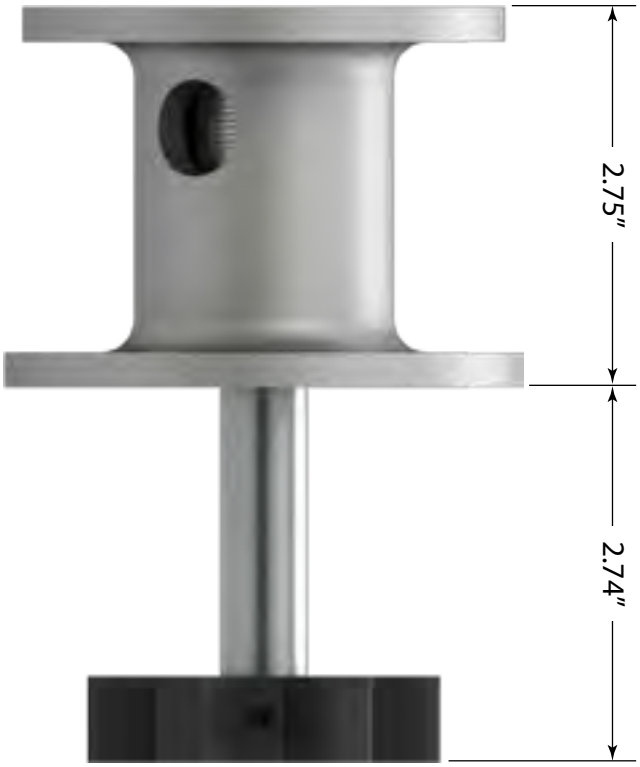
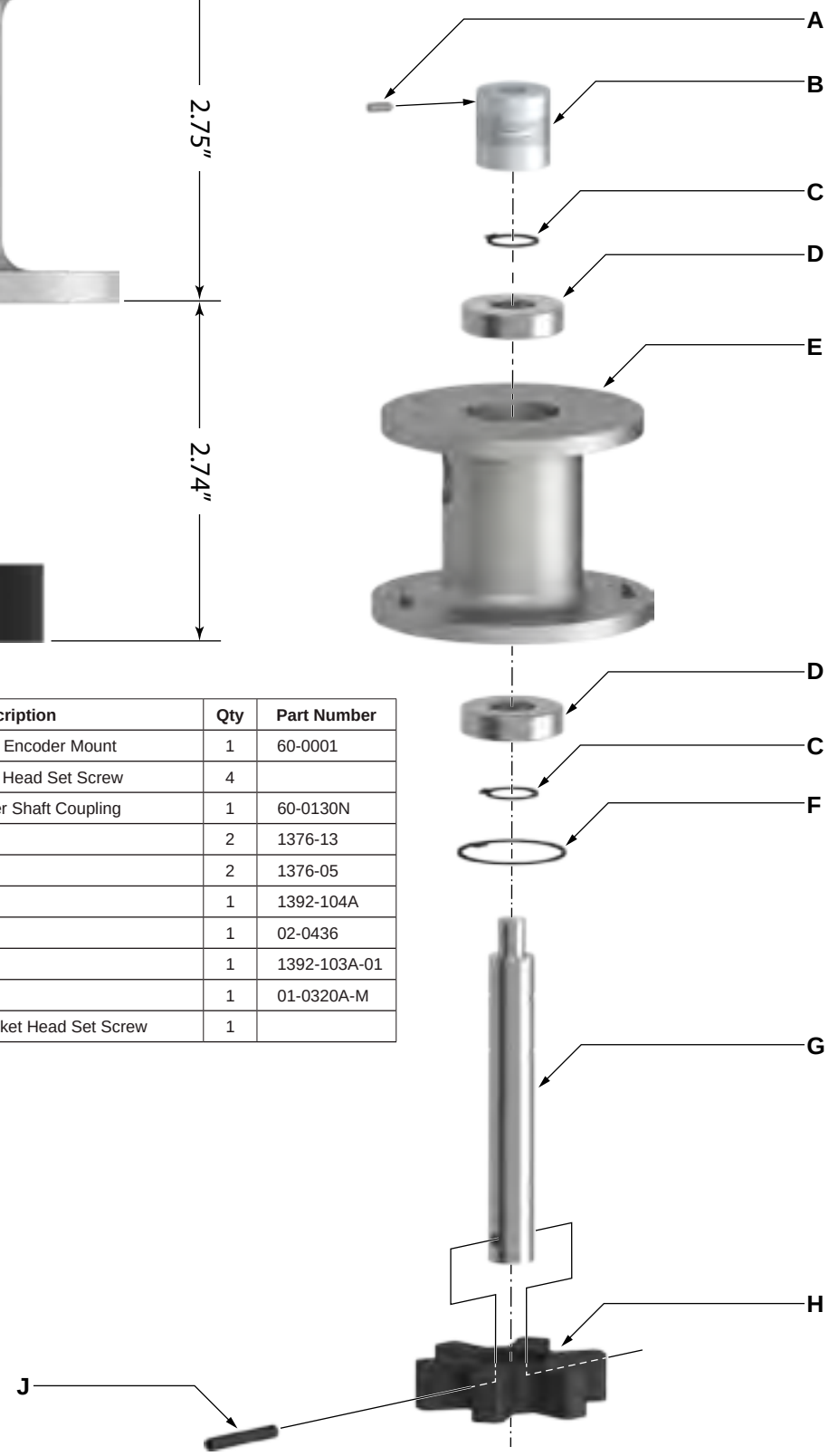


ILLUSTRATION 7.A.4: COMPRESSION LOAD CELL EXPLODED





Item	Type	Description	Qty	Part Number
	Assembly	Standard Turn Counter Encoder Mount	1	60-0001
A	Part	6-32 x 3/8" Hex Socket Head Set Screw	4	
B	Part	Helical Flexible Encoder Shaft Coupling	1	60-0130N
C	Part	Internal Retainer Ring	2	1376-13
D	Part	Bearing	2	1376-05
E	Part	Encoder Housing	1	1392-104A
F	Part	Internal Retainer Ring	1	02-0436
G	Part	Encoder Shaft	1	1392-103A-01
H	Part	Encoder Gear	1	01-0320A-M
J	Part	10-24 x 1-1/4" Hex Socket Head Set Screw	1	

Illustration 7.A.5: Turn Counter Encoder Mount Exploded

7.B TROUBLESHOOTING

Under normal operating conditions, and with proper maintenance, the torque gauge and load cell system are designed to give lasting trouble-free performance. Faulty indication on the gauge will very often define a fault within the gauge.

IF TROUBLESHOOTING REVEALS THAT THERE IS INSUFFICIENT FLUID IN THE SYSTEM, BEFORE RECHARGING, CHECK THAT ALL SYSTEM COMPONENTS ARE FREE FROM DAMAGE. THIS WILL ENSURE THAT FLUID LOSS WILL NOT CONTINUE AFTER RELOADING

1	SYMPTOM: NO INDICATION ON TORQUE GAUGE	
	POSSIBLE PROBLEM	**SOLUTION(S)**
	Hydraulic hose is obstructed	Check hydraulic hose for kinks
		Replace hydraulic hose
	Loss of hydraulic fluid	Recharge hydraulic fluid (see Section 6.C.2). NOTE: Ensure any breaches in the hydraulic system between the load cell and torque gauge are repaired to prevent further fluid loss.
	Internal mechanism of torque gauge is damaged	Replace gauge
2	SYMPTOM: GAUGE INDICATION UNEXPECTEDLY HIGH	
	POSSIBLE PROBLEM	**SOLUTION(S)**
	Excessive hydraulic fluid	Completely drain hydraulic fluid from torque gauge/load cell system. Recharge following the procedure in Section 6.C.2
	Internal mechanism of gauge is damaged	Replace gauge
	Incorrect torque gauge in use (not part of the original torque gauge/load cell pair)	Replace gauge with gauge properly calibrated for the load cell in service
3	SYMPTOM: GAUGE INDICATION UNEXPECTEDLY LOW	
	POSSIBLE PROBLEM	**SOLUTION(S)**
	Insufficient hydraulic fluid	Recharge hydraulic fluid (see Section 6.C.2). NOTE: Ensure any breaches in the hydraulic system between the load cell and torque gauge are repaired to prevent further fluid loss
	Obstruction in hydraulic hose	Check hydraulic hose for kinks
		Replace hydraulic hose
	Snub line not at right-angle to tong handle	Check angle of snub line and correct if necessary
	Internal mechanism of gauge is damaged	Replace gauge
	Incorrect torque gauge in use (not part of the original torque gauge/load cell pair)	Replace gauge with gauge properly calibrated for the load cell in service
4	SYMPTOM: GAUGE INDICATION IS ERRATIC OR SLUGGISH	
	POSSIBLE PROBLEM	**SOLUTION(S)**
	Insufficient hydraulic fluid in torque measurement section	Recharge hydraulic fluid (see Section 6.C.2). NOTE: Ensure any breaches in the hydraulic system between the load cell and torque gauge are repaired to prevent further fluid loss
	Loss of damping fluid in torque gauge	Top up or refill damping fluid (NOTE: Ensure leakage points in gauge are identified and repaired to prevent further loss of damping fluid)
	Air bubbles in hydraulic fluid in the torque measurement system	Bleed air from load cell and torque gauge and top up fluid (if necessary) as per Section 6.C.2
	Internal mechanism of gauge is damaged	Replace gauge

7.C PERIODIC INSPECTION AND MAINTENANCE

ONLY QUALIFIED, DESIGNATED PERSONNEL ARE PERMITTED TO PERFORM MAINTENANCE ON THE TORQUE MEASUREMENT SYSTEM.

7.C.1 Inspection

The torque measurement system supplied with your equipment is designed and built to provide years of trouble-free service with minimum maintenance. Periodic inspections of the load cell, hydraulic lines and fittings are recommended in order to keep the system in top operating condition. A thorough inspection should be made at each rig-up.

7.C.2 Fluid Recharge

Recharge hydraulic system with W15/16 fluid through the check valve on the torque indicating gauge. Recharging must only be performed when there is no load on the load cell. Refer to the illustrations on pages 6.3 & 6.4 for guidance if required.

a. Place the torque indicating gauge higher than the load cell. Remove the brass 1/4" cap from the fitting on the check valve on the top of the gauge.

b. Connect the hand pump to the check valve fitting.

c. Elevate the load cell so it is higher than the torque gauge and hand pump.

UN-CONTAINED SPILLAGE OF THE HYDRAULIC FLUID IN THIS SYSTEM MAY CONTRAVENE GOVERNMENTAL ENVIRONMENTAL REGULATIONS, OR THE ENVIRONMENTAL REGULATIONS AND POLICIES OF YOUR COMPANY. FARR CANADA CORP. HIGHLY RECOMMENDS PLACING YOUR LOAD CELL IN A CONTAINMENT BASIN BEFORE PROCEEDING WITH THE BLEEDING & REFILLING PROCESS.

d. Fill hand pump bowl with W15/16 hydraulic fluid.

MAINTAIN GREATER-THAN HALF FULL FLUID LEVEL IN THE HAND PUMP BOWL TO AVOID PUMPING AIR INTO THE SYSTEM. DO NOT ALLOW THE LEVEL TO FALL BELOW ONE-HALF FULL

e. Remove the vent plug screw and Stat-O-Seal (Items C and D on Illustration 6.A.4, or item H on Illustration 6.A.5) to allow trapped air to escape.

f. Pump fluid into the system until no more air is seen escaping from the vent port.

g. Replace the vent plug screw and Stat-O-Seal and tighten securely.

h. Remove load cell from containment vessel and wipe clean. Reclaim the hydraulic fluid (if it is clean) or dispose of all waste materials according to governmental or your company's proscribed environmental protection regulations.

i. Disconnect the hand pump from the torque gauge.

j. Replace the brass cap on the torque gauge check valve fitting.

7.C.3 Reference Checking Your Torque Measurement System

The following steps define a process for determining if your torque measurement system is correctly measuring and indicating within an expected range. This procedure is best suited for performing in a shop or location removed from the drill floor, within range of a crane. This is a reference check and not a calibration. Calibrations must be performed at an authorized calibration facility.

Tension Load Cell

a. Locate a known weight in the range of approximately 500 to 1000 lbs (227 to 455 kg), and move the weight next to the tong and backup assembly.

b. Remove the tension load cell from the tong, but do not disconnect from the torque gauge.

c. Suspend the load cell, piston side up, from a crane capable of supporting the known weight in Step 3a.

d. Connect the rod side of the load cell to the known weight, and use the crane to hoist the weight from the surface to be suspended freely.

Continued on next page...

7.C.3 Reference Checking Your Torque Measurement System (Continued):

Tension Load Cell (continued):

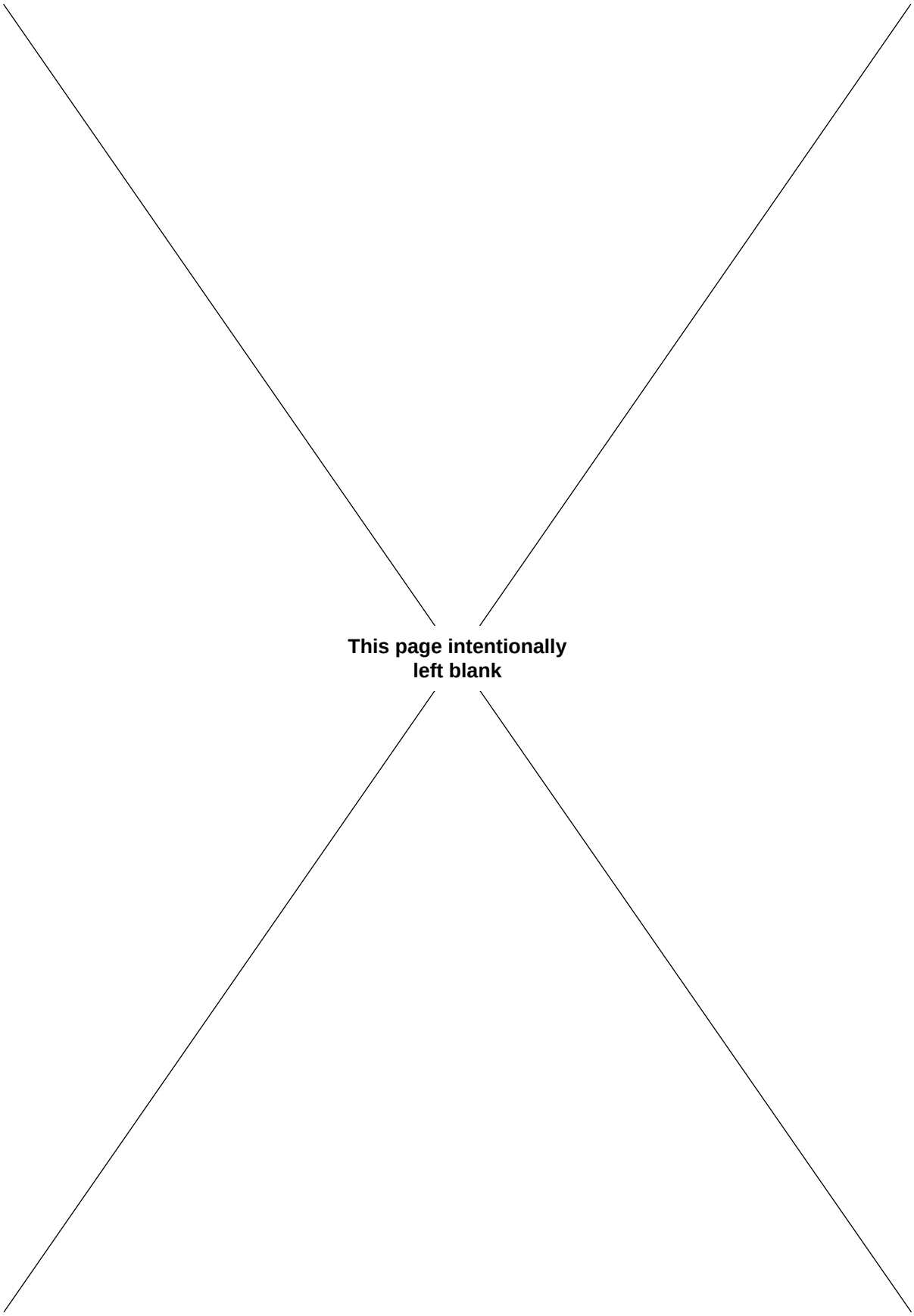
e. Perform a simple calculation to determine the expected indication on the torque gauge based on the known hoisted weight. This is a calculation that must be performed using imperial units (eg., pounds and feet). The calculation is: [KNOWN WEIGHT] x [ARM LENGTH (in feet)]. For example, if the arm length is 36 inches and the hoisted weight is 1000 lbs the calculation is:

1000 x (36/12) = 3000

Therefore, the expected indication on the torque gauge should be 3000 lbs-ft.

7.C.4 Repair And Calibration

Return the load cell and indicator gauge to the authorized repair facility for repairs and calibration.



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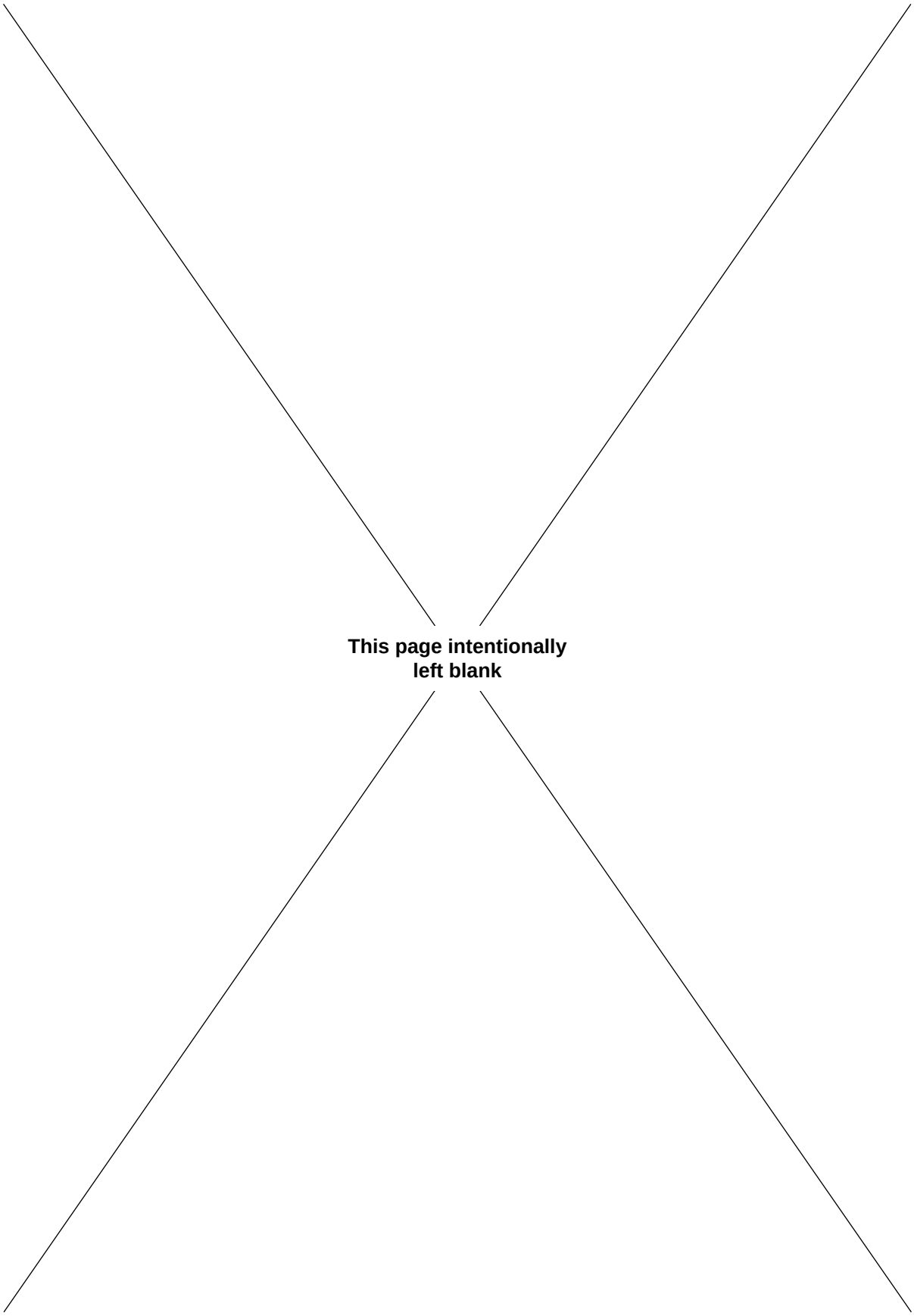
MOVING GLOBAL ENERGY FORWARD

DRILLING & COMPLETIONS

FARR

Section 8: OEM Documentation

The manufacturer information contained in this section has been obtained from publicly available web sites and has been provided for information purposes only. Farr Canada Corp. does not guarantee the accuracy of the information contained in this section. All original copyrights claimed by the manufacturer(s) apply.



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RINEER HYDRAULICS, INC. — Manufacturer of Hydraulic Motors

15 series

POWER to be the Best!

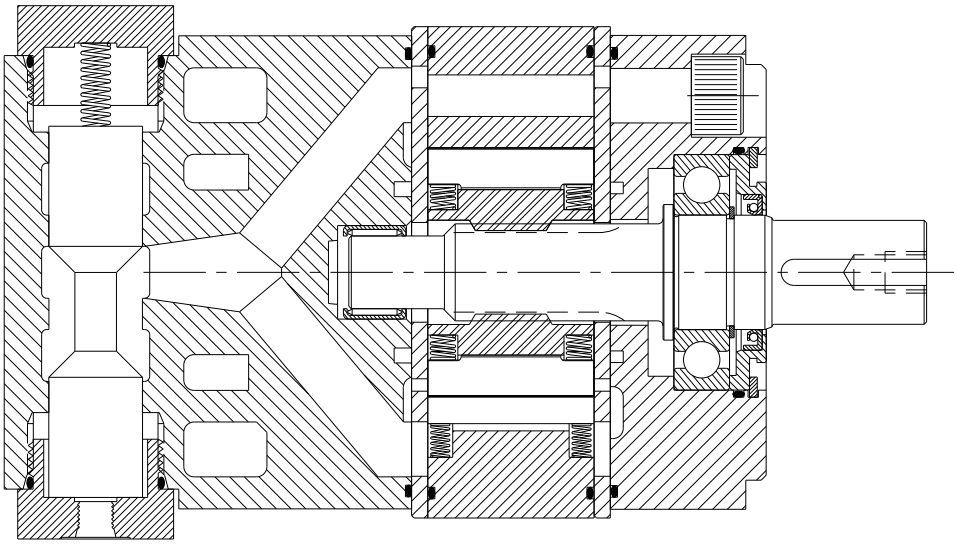
MOTOR SELECTION GUIDE

15 Series Two Speed

Weight = 51 lbs.

- All available displacements of standard motor.
- Spool valve shift from full to partial displacement.
- Standard shift ratio is 2:1 - Some special ratios available.
- Shift on the run.
- Typical applications - winch, track and wheel drives.

Cross Section - Two Speed Motor



Technical Information - Two Speed Motor

DISPLACEMENT CHANGE
When a motor is shifted from full to partial displacement the motor is changed to 50%, 35%, or 28% of its original displacement depending on its shift ratio.

STANDARD SHIFT RATIO
The standard 15 Series displacements of 15, 13, 9.5, 8, 7, and 6 CID are available in the 15 Series Two Speed with a shift ratio of 2:1. For example, a 15 CID motor shifted to partial displacement becomes a 7.5 CID motor.

SPECIAL SHIFT RATIOS
There are two special displacements available in the 15 Series Two Speed which offer higher shift ratios, the 10.5 and the 11.5 CID. The 10.5 CID motor has a shift ratio of 3.5:1, which when shifted becomes a 3 CID motor. The 11.5 CID motor has a shift ratio of 2.875:1, which when shifted becomes a 4 CID motor.

SHIFTING METHOD
Selecting between full and partial displacement is accomplished by shifting the two-position spool valve incorporated in the motor. Motors are available in either single or double pilot configurations.

SINGLE PILOT
Single pilot motors require a pilot line to be connected to port "C". When port "C" is pressurized the spool shifts the motor to partial displacement. When port "C" is vented to tank, an internal spring shifts the spool, returning the motor to full displacement.

DOUBLE PILOT
Double pilot motors require two pilot lines. One line is connected to port "C" while the other line is connected to port "D". The motor is in full displacement when port "D" is pressurized and port "C" is vented to tank. The motor is in partial displacement when port "C" is pressurized and port "D" is vented to tank.

OPEN DURING CROSSOVER SPOOLS
Open during crossover spools allow port "A" to be directly connected to port "B" when the spool is shifting between full and partial displacement. Motors with -62 or -65 designations are open during crossover.
WARNING! IN SOME WINCH APPLICATIONS, OPEN DURING CROSSOVER SPOOLS (-62 or -65) ARE NOT RECOMMMENDED.

CLOSED DURING CROSSOVER SPOOLS
Closed during crossover spools do not allow port "A" to be directly connected to port "B" when the spool is shifting between full and partial displacement. Motors with -63 or -67 designations are closed during crossover. These motors contain an internal factory preset relief valve. This valve protects the motor during shifting only and is not a system relief valve.

PILOT PRESSURE
A minimum of 100 PSI over case drain pressure is required to shift the spool. The maximum allowable pressure to port "C" or "D" is 3,500 PSI.

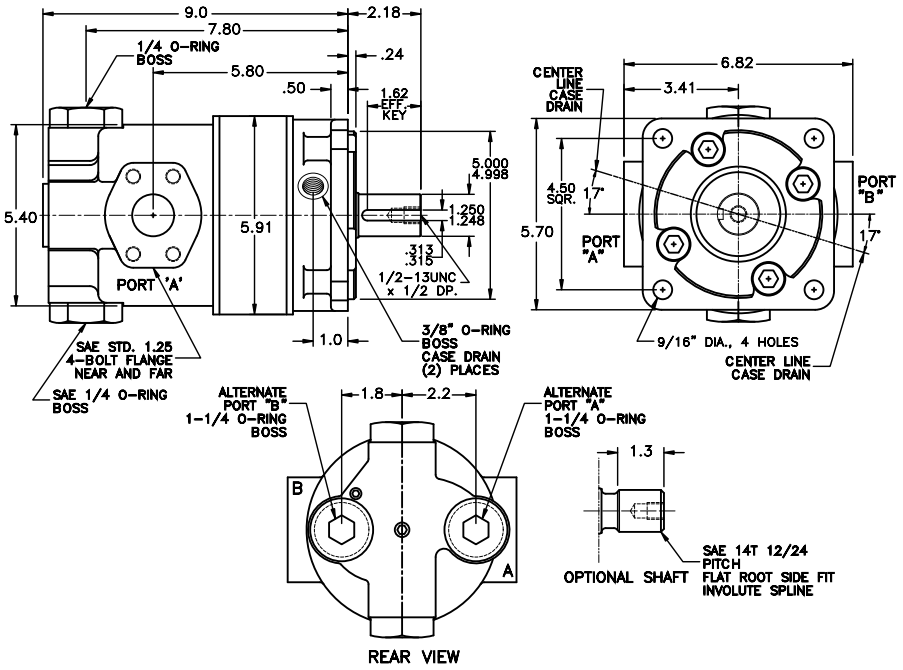
SHIFT ON THE RUN
The 15 Series Two Speed Motor may be shifted on the run while loaded or unloaded.

MAXIMUM SPEED
Maximum rated speed is the same for either full or partial displacement as stated in the performance data.

CASE DRAIN AND CROSS PORT LEAKAGE
The combined case drain and cross port leakage of the 15 Series Two Speed Motor is approximately 1 GPM per 1,000 PSI. This will vary with the oil viscosity.

OTHER INFORMATION
All other information as specified under Techinal Information also applies to the 15 Series Two Speed Motor. (See page 5)

15 Series Two Speed Envelope



MCCOY MOVING GLOBAL ENERGY FORWARD | DRILLING & COMPLETIONS

Technical Information - All Styles

VANE CROSSING VANE
The Rineer patented vane crossing vane design produces much higher volumetric and mechanical efficiencies than is possible with a standard vane type design. This design provides a sealing vane between cavities to improve mechanical and volumetric efficiencies.

STARTING AND STALL TORQUE
The Rineer motor produces torque curves which are virtually flat, with starting and stall torque equal to approximately 90-94% of theoretical torque.

MORE POWER STROKES PER REVOLUTION
The 15 Series has four stator cavities and 10 rotor vanes. Each rotor vane works in each stator cavity once per revolution, which results in 40 power strokes per revolution. This helps produce higher mechanical efficiency and flatter torque curves.

BEARING LOADING
The bearings in the 15 Series can accept radial load per the radial capacity chart. Thrust load is not recommended under most conditions. Consult with a Rineer Application Engineer for optional bearing configurations to match your application.

SEALS
Buna N seals are supplied as standard on the Rineer 15 series motors. Viton seals may be ordered as an option.

ROTATING GROUP - 1S or 1H
Under most operating conditions, 1S (standard rotating group parts) should be used. Under some high speed conditons 1H can be specified.

ROTATION
The 15 Series Motor rotates equally well in either direction and smoothly throughout its entire pressure and speed range. Looking into the end of the shaft, rotation is clockwise when oil is supplied to port "A".

HORSEPOWER LIMITATION
Maximum horsepower limitations may vary with different applications. ***When using the 15 Series Motor above 75 HP, consult a Rineer Application Engineer.***

FILTRATION
25 micron minimum.

FLUID
We suggest premium grade fluids containing high quality rust, oxidation and foam inhibitors, along with anti-wear additives. For best performance, minimum viscosity should be maintained at 100 SSU or higher. Fluid temperature should not exceed 180° F. Elevated fluid temperature will adversely affect seal life while accelerating oxidation and fluid breakdown. Fire resistant fluids may be used with certain limitations. Contact Rineer for additional information.

CASE DRAIN
The 15 Series Motor is designed for either internal or external case drain. Two case drain ports are supplied. When using internal case drain, simply plug the two ports. When using external case drain, use the port at the highest elevation. We recommend case drain pressure of 35 PSI or less when using the standard seals.

CASE DRAIN CIRCULATION
Fluid should be circulated through the case when a temperature differential exists between the motor and the system in excess of 50° F. ***Should this occur, contact a Rineer Application Engineer.***

MOUNTING
The mounting position is unrestricted. The shafts, pilots, and mounting faces should be within .002 TIR.

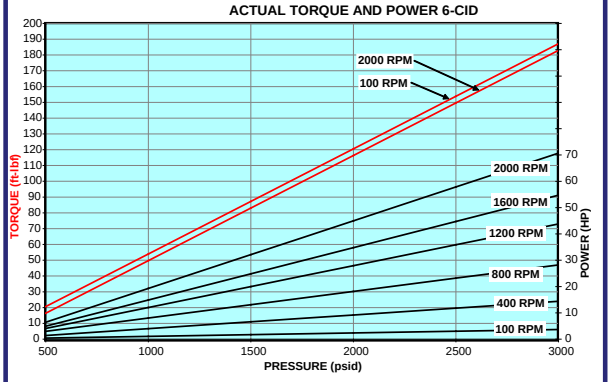
INTERMITTENT CONDITIONS
Intermittent conditions are to be less than 10% of every minute.

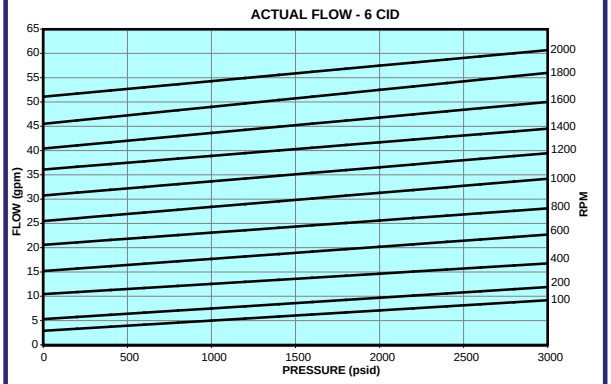
OTHER AVAILABLE MOTORS
For information on additional Rineer Motors, request one of the following publications:

37 Series .....Publication DS371003
57 Series .....Publication DS571003
125 Series .....Publication DS1251003

Performance Data - Selected Displacements

6 C.I.D.





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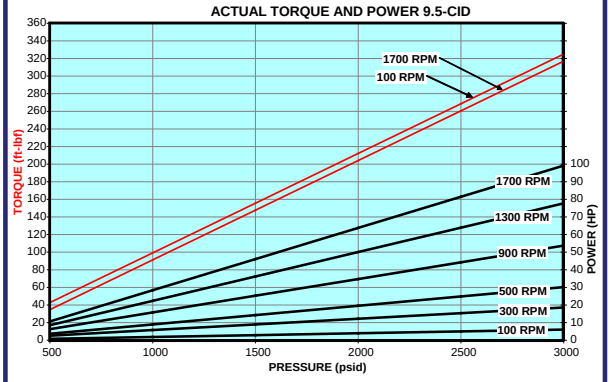

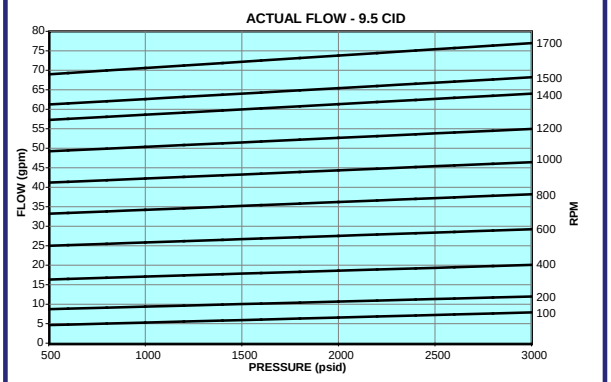

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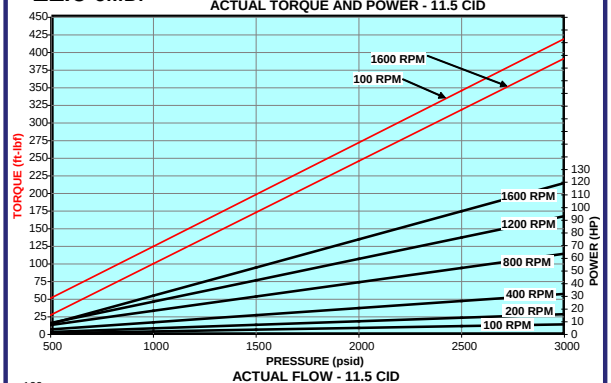
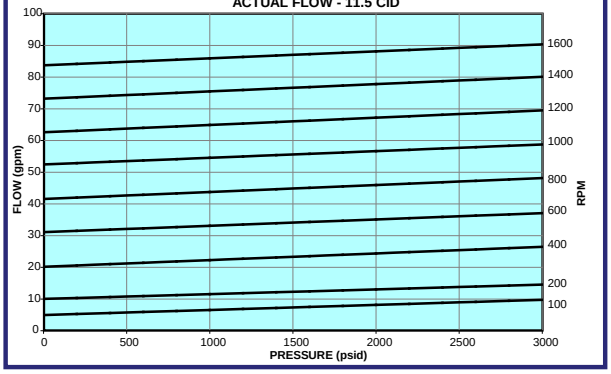
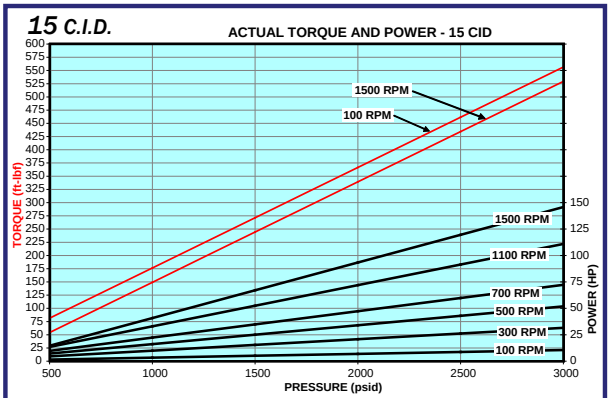
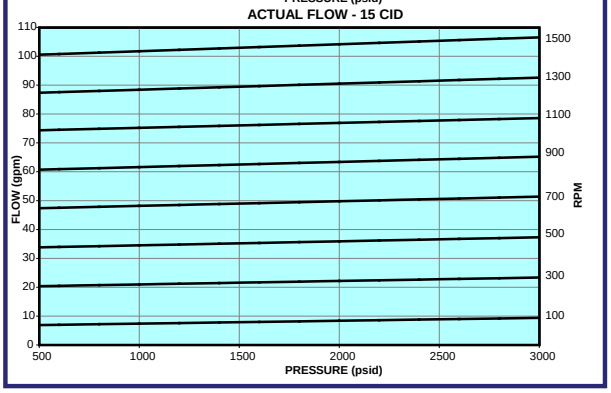




15 C.I.D.





The above performance data was obtained at 140°F with ISO 46(DTE 25). These values must be maintained to obtain the performance indicated. Contact Rineer Hydraulics, Inc. for additional displacements.

Model Code

M015 - 61/62

M015 - 61 = 015 Single Speed
M015 - 62 = 015 Two Speed

Options:
62 = Two Speed Single Pilot Open During Crossover
63 = Two Speed Single Pilot Closed During Crossover
65 = Two Speed Double Pilot Open During Crossover
67 = Two Speed Double Pilot Closed During Crossover

-1S

1S = Std.
1H = High Speed

-015

006 = 6 in^3 (98cc)/rev.
007 = 7 in^3 (115cc)/rev.
008 = 8 in^3 (131cc)/rev.
009 = 9.5 in^3 (156cc)/rev.
010 = 10.5 in^3 (172cc)/rev.
011 = 11.5 in^3 (189cc)/rev.
013 = 13 in^3 (213cc)/rev.
015 = 15 in^3 (246cc)/rev.

-31

30 = Keyed Shaft
31 = Splined Shaft
32 = Wheel Motor
34 = Double Key
50 = Retractable
53 = API Thread

-B1

Bearing Package Selection

-TV

Seal - Package Selection

-000

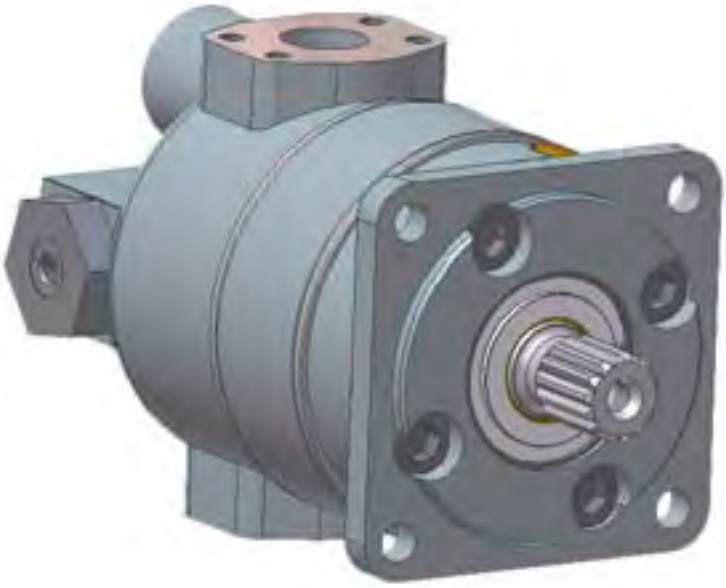
Special Code Designator

Applications

Repair Manual

15 Series

Standard Motor



Two Speed Motor

331 BREESPORT * SAN ANTONIO, TX 78216 * (210) 341-6333 FAX (210) 341-1231

MCCOY DRILLING & COMPLETIONS
MOVING GLOBAL ENERGY FORWARD

SERIES 15 STD. TWO SPEED EXP. VIEW

ITEM	PART NO.	DESCRIPTION	QTY
1	0150111	SEAL PLATE SNAP RING	1
2	0150135	SEAL PLATE	1
3	1250161	SEAL, SHAFT, TCN	1
4		NOT USED	
5	0150114	SEAL PLATE O-RING	1
6	0150730	SNAP RING, BEARING	1
7	0150710	BALL BEARING	1
	0150701	SHAFT, KEYED	1
8	0150702	SHAFT, SPLINED	1
9	0150901	BOLT	4
10	0150102	FRONT HOUSING-INTERNAL	1
11	0150428	DOWEL PINS – FRONT	2
12	0150610	O-RING	4
13	0150902	BALL CHECKS	4
14	0150620	PLATE SCREW	4
15	0150609	PLATE, TWO SPEED	2
16	0150401	STATOR GA 15	1
	0150402	STATOR GA 13	1
	0150403	STATOR GA 9.5	1
	0150404	STATOR GA 8.0	1
	0150407	STATOR GA 6	1
	0150408	STATOR GA 10.5-2S	1
	0150414	STATOR GA 11.5-2S	1
	0150419	STATOR GA 5	1
17	0150300	ROTOR	1
18	0150313	ROTOR VANE	10
19	0150320	ROTOR VANE SPRING OUTER	20
20	0150321	ROTOR VANE SPRING INNER	20
21	0150410	STATOR VANE	4
22	0150420	STATOR VANE SPRING	8
23	0150429	DOWEL PINS – REAR	2
24	0150720	NEEDLE BEARING	1
25	0150841	REAR HOUSING, TS, #62	1
	0150842	REAR HOUSING, TS, #63	1
	0150843	REAR HOUSING, TS, #64	1

SERIES: **15**

EXPLODED VIEW

MODEL CODE: **015-62-1S-015-30 [31]-B1-TB**

STANDARD TWO SPEED

RINEER HYDRAULICS
CORPUS CHRISTI, TEXAS

RECORD REFERENCE
DRAWN BY: JERRY W

DATE: 6-19-00
DWG. NO. 0150044

WARNING: RINEER RECOMMENDS FOLLOWING ALL STANDARD SHOP SAFETY PRACTICES SPECIFICALLY INCLUDING WEARING OF EYE PROTECTION.

REMOVAL OF SHAFT SEAL

1

1) Remove snap ring

WARNING: Use caution when removing snap ring. If released accidentally it can become an airborne hazard.

2

1) Pry out shaft seal plate with two screw drivers.
2) Remove seal plate o-ring from groove in bearing bore.

REMOVAL OF WHEEL MOTOR SEAL PLATE AND BEARING BOX

3

1) Loosen and remove 8 each 10-32 bolts.
2) Pry off seal plate with screw driver.

4

Loosen and remove 8 each 3/8" bolts with 5/16" socket head wrench.

5

1) Two of the 3/8" bolt holes are provided with jack screw threads.
2) Insert a piece of 1/4" round stock by 2-1/2" long into each jack screw hole
3) Screw two 7/16-14 bolts into the jack screw threads until the bearing box is free of the motor.

6

Lift up on the bearing box to remove from motor.

DISASSEMBLY OF WHEEL MOTOR BEARING BOX

7

1) Loosen clamp screw in lock nut.
2) Unscrew lock nut and remove.

8

1) Press shaft out of bearing box.
2) Proceed to step 9, disregarding steps 11 & 12

WARNING: RINEER RECOMMENDS FOLLOWING ALL STANDARD SHOP SAFETY PRACTICES SPECIFICALLY INCLUDING WEARING OF EYE PROTECTION.

DISASSEMBLY OF FRONT HOUSING AND SHAFT

9

1) Mark one side of the motor for proper assembly, paying careful attention that the cartridge will not be installed upside down.
2) Secure the motor prior to loosening the 5/8-11 bolts.

10

1) Remove front housing
2) Note: Two 5/16" ball checks and one main body o-ring may be dislodged and fall free.

11

With the seal plate removed, press shaft and ball bearing out of front housing.

12

1) Remove snap ring from shaft.
2) Press shaft out of bearing.

DISASSEMBLY OF ROTOR/STATOR CARTRIDGE

13

Lift up rotor/stator cartridge and remove from the rear housing.

14

1) Place cartridge on any object which will hold it off the table.
2) Remove two each 10-32 place screws.
3) Remove timing plate.

15

1) Remove o-ring and springs with a small screwdriver.
2) Remove dowels pins.

16

1) Replace plate on rotor/stator cartridge.
2) Turn rotor/stator cartridge over.
3) Repeat steps 14 & 15.

WARNING: RINEER RECOMMENDS FOLLOWING ALL STANDARD SHOP SAFETY PRACTICES SPECIFICALLY INCLUDING WEARING OF EYE PROTECTION.

17

1) Remove the rotor.
2) Remove both the rotor and stator vanes.
3) Note: On motors manufactured prior to 1987, rotor vane slots and rotor vanes should be numbered so that vanes can be reassembled in the same vane slot.

INSPECTION AND REPLACEMENT OF PARTS

18

Inspect all springs and seals. We recommend replacement of all seals and springs whenever the motor has been disassembled.

19

Inspect all parts and replace any parts which obviously show excessive wear or damage.

20

VANES: Normal wear results in slight flattening of vane tips which does not impair motor performance. Replace vane if radius is reduced by 50%. Clearance between the rotor vane and rotor vane slot varies with the vane selection. The design allows the vane to "lean" slightly in the slot, providing the required mechanical seal.

21

PLATES: Normal wear results in marking of timing plates which does not impair motor performance. Replacement of the timing plate is required if any smearing, galling, or heat cracks are present.

22

ROTOR: Normal wear results in polishing of rotor faces which does not impair motor performance. Examine the rotor vane slots closely. Polishing down in the slots is normal, but if there is any indication of a "pocket" forming in the wall of the slot, the rotor should be replaced.

23

STATOR: Normal wear results in polishing of cam form which does not impair motor performances. Noticeable wear may be apparent along the corner of one side of the staor vane slot. This does not necessarily require replacement of the stator, but may slightly affect volumetric efficiency.

24

Note: Measure the rotor and stator length to the fourth decimal point and supply measurement when ordering rotor, stator, or vanes.

MCCOY MOVING GLOBAL ENERGY FORWARD | DRILLING & COMPLETIONS

WARNING: RINEER RECOMMENDS FOLLOWING ALL STANDARD SHOP SAFETY PRACTICES SPECIFICALLY INCLUDING WEARING OF EYE PROTECTION.

ASSEMBLY OF ROTOR/STATOR CARTRIDGE

25

1) Reverse the procedures in steps 17, 16, 15, and 14
2) NOTE: Make sure that the radiused edge of each stator vane points to the rotor and the radiused edge of each rotor vane points to the stator.
3) NOTE: Make sure springs are seated in the bottom of the spring pocket in both the rotor and stator.

ASSEMBLY OF FRONT HOUSING

26

1) Press bearing onto shaft.
2) Install snap ring.

27

Press shaft and bearing assembly into front housing by pressing on the outer race of bearing.

28

1) Place seal in seal plate.
2) Place seal plate o-ring into groove in the front housing.
3) Press seal plate into front housing.
4) Install snap ring.
5) Proceed to step 30.

ASSEMBLY OF WHEEL MOTOR FRONT HOUSING

29

1) Reverse the procedures in steps 8 thru 3.
2) Screw lock nut onto shaft until all threads are engaged.
3) Tighten clamp screw until lock nut turns with a slight drag.
4) Tighten lock nut until desired rolling drag of bearing is obtained - see procedure Page 9.
5) Tighten clamp screw
6) Tighten all seal plate bolts.

ASSEMBLY OF MOTOR

30

1) Install dowel pins into rear housing.
2) Install ballchecks into rear housings.
3) Install main body o-ring.

31

1) Place rotor/stator cartridge onto rear housing.
2) NOTE: Make sure assembly marks from step 3 are lined up.

32

1) Install main body o-ring into front housing.
2) Install ball checks into front housing.
3) Place a small amount of grease over ball checks and o-ring.
4) Wipe off excess grease.

WARNING: RINEER RECOMMENDS FOLLOWING ALL STANDARD SHOP SAFETY PRACTICES SPECIFICALLY INCLUDING WEARING OF EYE PROTECTION.

33

1) Install dowel pins into rotor/stator cartridge.
2) Pour a small amount of clean oil into the cartridge.
3) Install front housing onto rotor/stator cartridge.
4) Make sure alignment marks are lined up.

34

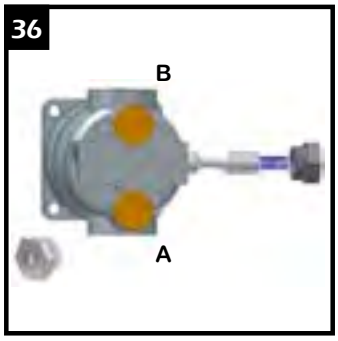
1) Install 5/8-11 bolts.
2) Torque bolts to 50 ft./lbs.

35

1) Rotate shaft in both directions to assure that the shaft turns smoothly.
2) Torque motor to 190 ft./lbs.
3) Rotate shaft again in both directions to assure that the shaft turns smoothly.

SPOOL ASSEMBLY FOR THE TWO SPEED MOTOR

36



NOTE: Spool should be oriented as shown for two speed motors with model codes 62, 63, 68, & 69.

NOTE: Slight design variations may exist in motors manufactured either before or after the printing of this manual.

WHEEL MOTOR SHAFT AND BEARING ASSEMBLY PROCEDURE

1) Clean ALL assembly parts w/ lacquer thinner.
2) Dip clampnut and clamping bolt separately in lacquer thinner.
   (Steps 3 thru 10 must be conducted to completion ONE assembly at a time.)
3) Press bearing cups into bearing housing. Make sure they are pressed completely against bearing shoulders.
4) Coat inner race of large cone with #609 (green) Loctite and press cone onto the shaft. Make sure the cone is completely against the shoulder of the shaft.
5) Insert shaft and large cone into bearing housing.
6) Coat inner race of small cone with #609 (green) Loctite and press small cone onto shaft.
7) Apply #272 (red) Loctite to the clampnut threads of the shaft. Apply #242 (blue) Loctite to the threads of the clamping bolt and install in the clampnut.
8) Spin clampnut onto shaft with the "B" face towards bearings. After the nut threads are fully engaged, but prior to the nut contacting the bearings, tighten the clamping bolt until there is drag on the clamping nut (see note Fig. 1). Tighten the nut until a 20 to 30 inch pound rolling torque is achieved.
9) Tighten clamping bolt on clampnut to 70 inch pounds and recheck rolling torque. Apply inspectors lacquer to head of the bolt.
10) Allow a minimum of 24 hrs. to dry.

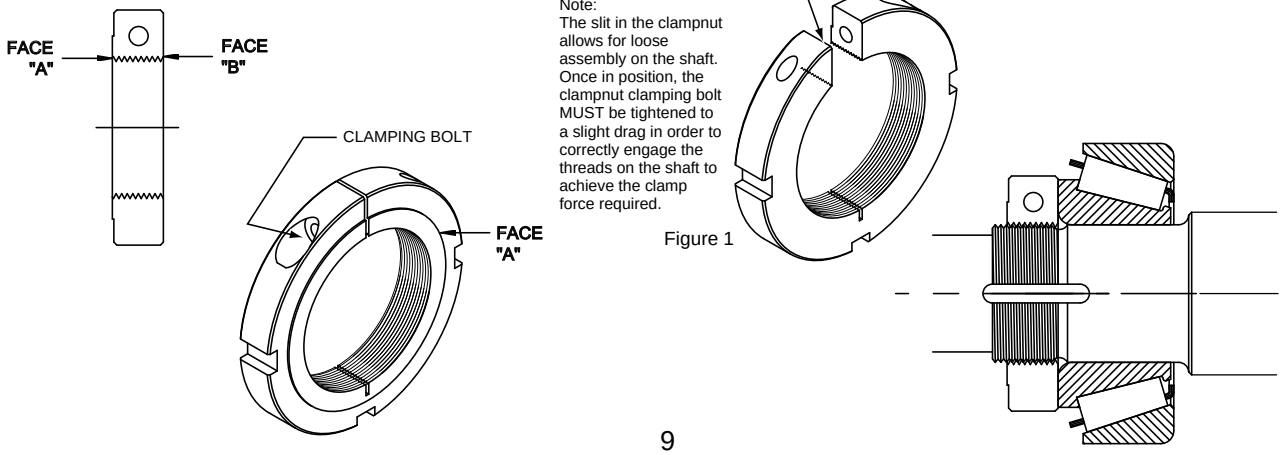

FACE "A"
FACE "B"
CLAMPING BOLT
FACE "A"
CUTAWAY
Note:
The slit in the clampnut allows for loose assembly on the shaft. Once in position, the clampnut clamping bolt MUST be tightened to a slight drag in order to correctly engage the threads on the shaft to achieve the clamp force required.

Figure 1

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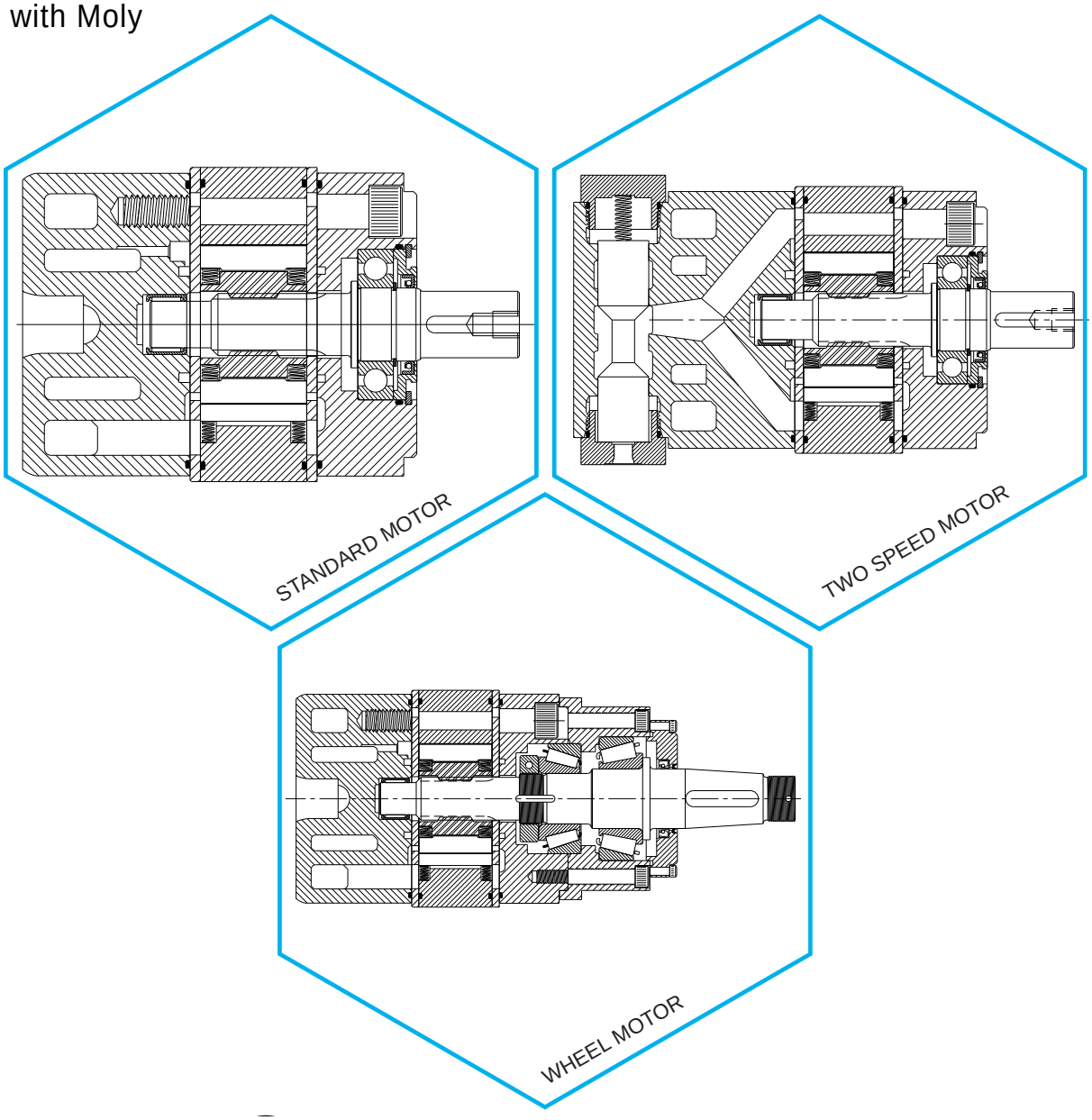
Information:

Bolt Torque -
- Main Bolts (5/8-11): 190 ft. lbs.
- Seal Plate (3/8-16)
- (Wheel Motor only): 45 ft. lbs.

Grease used for bolt threads and o-ring retention:
- Pennzoil 707L RED

Shaft seal assembly lube:
- Mobilgrease special with Moly

Seal Kits:
- Standard 15 series seal kit #0150940
- Standard 15 two speed seal kit #0150940
- Standard 15 wheel motor seal kit #0150936



Inlets (2500 psi)

End Inlet

End Port	Top Port
1" NPT	1" NPT
SAE-16	SAE-16
SAE-20	SAE-16
NON-PORTED HOUSING	

Schematic shown with main R/V

Outlets

Tank Return Type

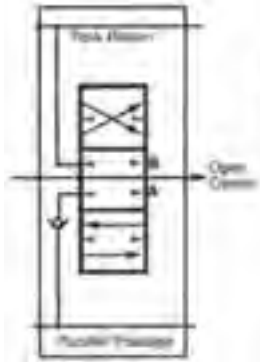
Code	End Port	Top Port
DVA35-TR55	1 1/4" NPT	1 1/4" NPT
DVA35-TR99	SAE-20	SAE-20
DVA35-TR00	NON-PORTED HOUSING	

NOTE: See Section G, Page 32 for Port Plugs

Adjustable Relief Valve Cartridges

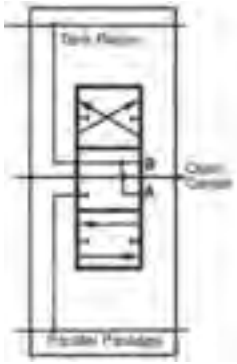
For Inlets and Mid-section Inlets

Code	Description
DVA35-MRV-1	Main R/V pressure range 800-2000 psi. Factory set @ 1500 psi @ 50 gpm
DVA35-MRV-2	Main R/V pressure range 2001-2500 psi. Factory set @2500 psi @ 50 gpm
DVA35-MRVP	Main relief valve plug



DA8

Double-Acting Section
4-Way, 3-Position, Hold in Neutral
Cylinder Spool



MA8

Double-Acting Section
4-Way, 3-Position, Float in Neutral
Motor Spool

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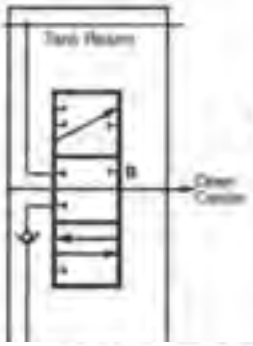


SA8

Single-Acting Section
3-Way, 3-Position, Hold in Neutral
Cylinder Spool

Brief Circuit Descriptions

Series Circuit

Available in DVA20 sections only.

If a machine's work cycle requires simultaneous as well as separate operation of individual hydraulic work functions, a series circuit is right for the job.

As with the other circuits, the oil flows through the open center when all spools are in neutral. There is no parallel passage in standard series sections because they feed directly from the open center passage. If more than one spool is operated, pump flow goes first to the section closest to the inlet. Return flow from the first section is fed back into the open center for use by downstream sections.

Downstream sections can be series, parallel or tandem and will operate in series with the upstream section.

In series circuits, operating pressure is cumulative. Therefore, the sum of the pressures in the circuits can not exceed the circuit or main relief valve setting.

Parallel Circuits

Parallel circuits are the most common on mobile equipment because more than one function can be operated simultaneously and at random. If two or more functions are fully operated at the same time, the one with the lightest load will assert priority because the fluid will take the path of least resistance. However, the operator can divide the flow between functions by metering the spools.

Movement of the spool meters or shuts off the flow of oil thru the open center passage and pressurizes the parallel passage. Oil is then available at the operator's discretion, to all work ports connected to the parallel passage.

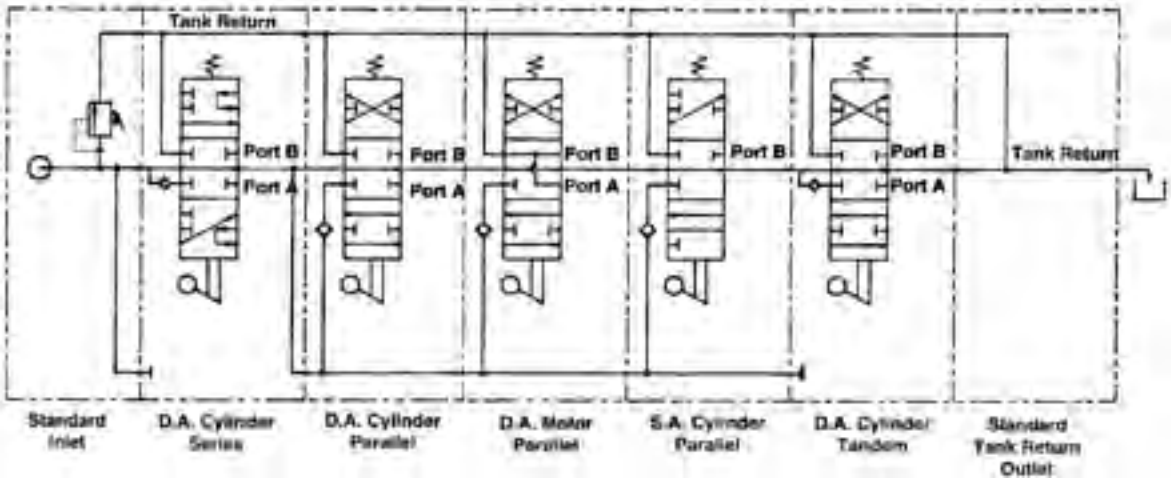
Tandem Circuits

(Not available in the program)

Tandem circuits are sometimes called priority or standard circuits by other manufacturers. Tandem sections feed from the open center passage like series sections but the return flow is directed to the tank return passage and is not available downstream.

If a tandem section is followed by a series or tandem section, operating the tandem section nearest the inlet will assert priority and downstream sections will not function.

Typical Work Section Schematics



VA™/VG™ Valve Service Instructions

INTRODUCTION

This manual has been prepared to assist you in the proper maintenance of the VA20™/VA35™ and VG20™/VG35™/VG80™ directional control valves. Before any work is done, we suggest that you read the assembly and disassembly instructions completely.

The first rule of good maintenance is cleanliness, which includes a clean environment. MAKE SURE YOU DISASSEMBLE AND ASSEMBLE YOUR HYDRAULIC EQUIPMENT IN A CLEAN AREA. Dirt is the natural enemy of any hydraulic system.

GENERAL INFORMATION

The VA and VG model valves are updated versions of our proven A20™ and A35™ units. The VG models are cast from compacted graphite, a high strength iron alloy, which allows the valve to be rated to 3500 psi. VA models are cast from gray iron and are rated at 2500 psi. These open-center, directional-control valves are available in parallel, tandem, and series circuitry. As needed, the sectional, stack-type construction provides flexibility for the addition of subtraction of work sections to an existing valve bank. This design also permits the combination of parallel, tandem, and series circuitry in a single bank. The internal coring of each valve section determines its circuitry and the number of gasket seals required.

All sections with optional features, such as port relief valves, crossover relief valves, and anti-cavitation checks, are dimensionally larger when measured from the top of the port to the bottom of the housing. These are referred to as "hi-boy" sections. Those without work-port options can use the low-profile castings, which are called "lo-boy" sections.

REPLACEMENT PARTS

The illustrations and instructions in this manual apply only to the VA/VG series assemblies, subassemblies, and components. All valve components, except for spools and housings, are available as replacement parts or subassemblies. Spools are lone-fitted to their individual housings, so damage to either of these components means the entire section must be replaced.

We recommend that you use only genuine VA/VG series replacement parts in your service program. Manufactured to the same exacting tolerances and quality controls as the original equipment, genuine VA/VG replacement parts may help prevent premature, component failure and costly downtime. Service parts and assemblies are available through your original equipment dealer or any authorized distributor.

MAINTENANCE

Valves are often used in hazardous environments. Inspect them frequently for damage due to improper use, corrosion or normal wear. If needed, repairs should be made immediately.

Always refer to the machine manual for the proper procedure to remove the valve from the machine.

Remove the valve bank from the equipment, disconnecting all hoses, fittings, control handles and linkage connectors that might be attached to the valve. Plug all ports and thoroughly clean the exterior of the valve bank, then the port plugs can be removed.

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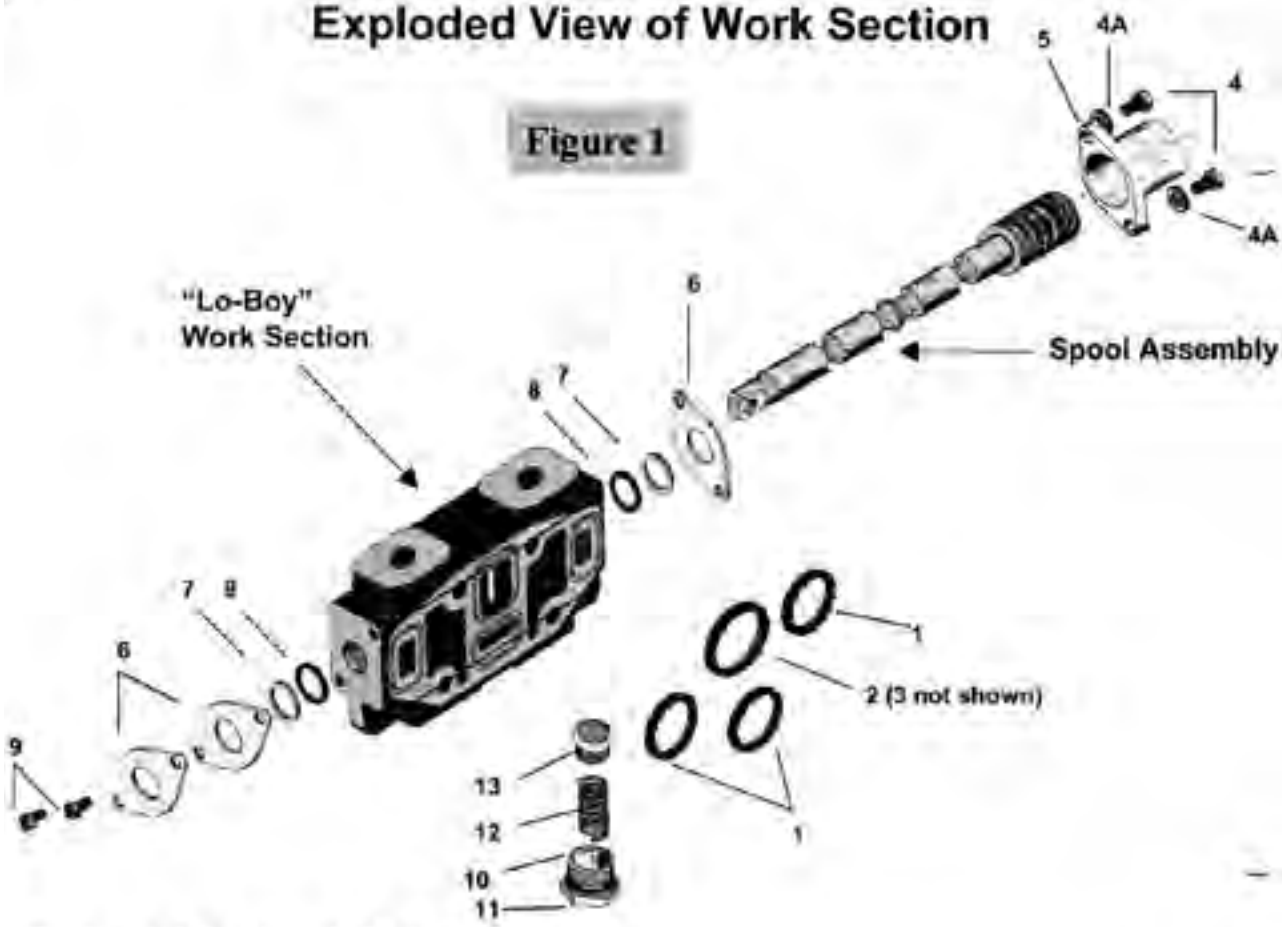
Exploded View of Work Section

Figure 1

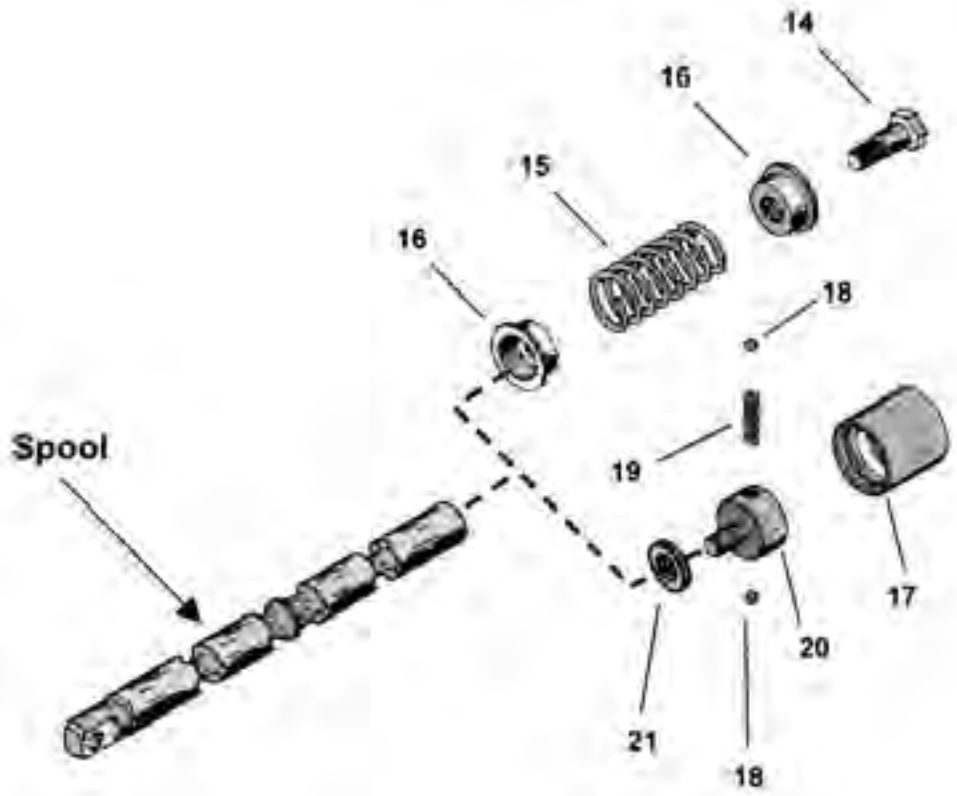


Parts List For Work Section

Item	Description	Qty.	VA/VG20 Part No.	VA/VG35 Part No.	VG80 Part No.
Parallel Section Seals* See Figure 1					
1	Square Seals	3	391-2881-206	391-2881-200	391-2881-433
2	Square Seal	1	391-2881-200	391-2881-403	391-2881-670
Series Section Seals					
1.	Square Seals	2	391-2881-206	391-2681-200	.....
3.	Square Seal	1	391-2881-627	391-2681-628	.....
Parallel and Series Section Component Parts. See Figure 1					
4	Back Cap Screws	2	391-1433-020	391-1433-099	(4) 391-1402-068
4A.	Lock washers	6	.....	.....	391-3783-039
5	Back Cap	1	341-6000-100	342-6000-100	341-0585-099
6.	Retainer Plates	3	391-2183-001	391-2183-005	391-2183-157
7.	Back up Rings	2	391-2681-378	391-2681-426	391-2681-285
8.	Spool Seals	2	391-1985-014	391-2887-212	391-2881-066
9.	Retainer Plate Screws	2	391-1433-015	391-1433-002	(4) 391-1402-015
10.	Check Valve Cap	1	391-0581-044	391-0581-044	391-0585-099
	Or Valve Cap (F.I.N.)	1	391-2281-015	391-2281-015	.....
11	O Ring Seal **	1	391-2881-204	391-2881-204	391-2881-249
12	Check Spring **	1	391-3581-713	391-3581-713	391-3581-778
13	Check Valve Poppet **	1	391-2481-069	391-2481-069	391-2383-091

*Parallel Sealing Face includes inlets and mid-inlets.
**Not required in Float-in-neutral Sections.

Figure 2



Spring Centered and Detent Spool Operators. See Figure 2

14.Stripper Bolt	1	391-1432-022	391-1432-021	391-1402-452
15.Centering Spring	1	391-3581-608	391-3581-633	391-3581-330
16.Spring Guides	2	391-1642-045	391-1642-013	391-1642-161
17.Detent Sleeve	1	391-3283-015	391-3283-008	391-3384-310
18.Detent Balls	2	391-0282-010	391-0282-009	391-0282-011
19.Detent Spring	1	391-3581-130	391-3581-015	391-3581-316
20.Detent Poppet Retainer	1	391-2583-008	391-2583-006	391-3384-311
21.Detent Spacer	1	.....	.....	391-3782-208

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MOVING GLOBAL ENERGY FORWARD

4

Valve Disassembly Instructions

Reference exploded view and parts list on page 2 and 3 for work section detail.

Step 1 - Valve Bank

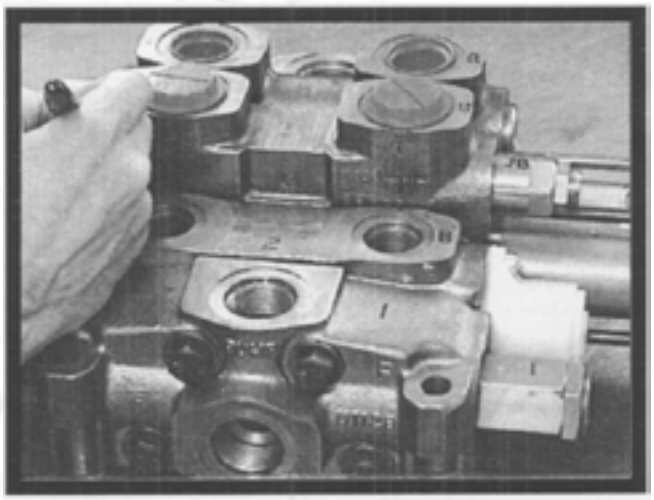
This step is the most critical in the disassembly procedure. It should be followed closely to ensure that the valve bank is properly reassembled after repairs have been made.

With a waterproof, quick-drying marker, mark each casting with a sequential number. Start by marking the inlet casting with the #1 and finish by marking the outlet with the highest number.

Next, mark the port boss closest to the back cap on each work section with a "B" (for back cap end).

Then, mark the port boss closest to the spool clevis on each work section with a "C" (for clevis end).

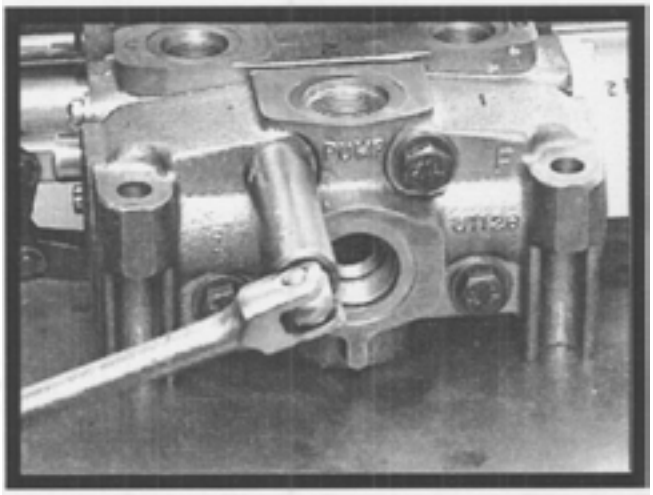
Finally, if relief valves are removed from the valve bank they must be marked with the corresponding number of the casting and port location (B or C) from which they were removed. Inlet and mid-inlet relief valves are marked with a casting number only.



Step 2 - Tie Bolts

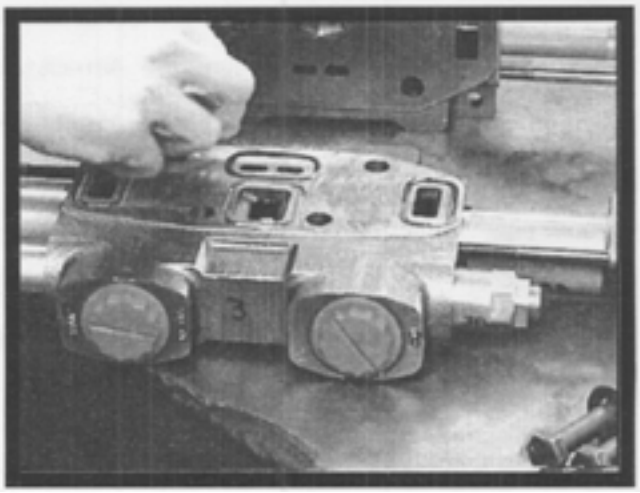
Remove the four tie bolts that hold the bank together and separate the sections.

NOTE: VA valve tie bolts thread into the outlet casting. VG valve tie bolts pass through the entire bank, requiring washers and hex nuts to be fastened at both ends of the bolt.



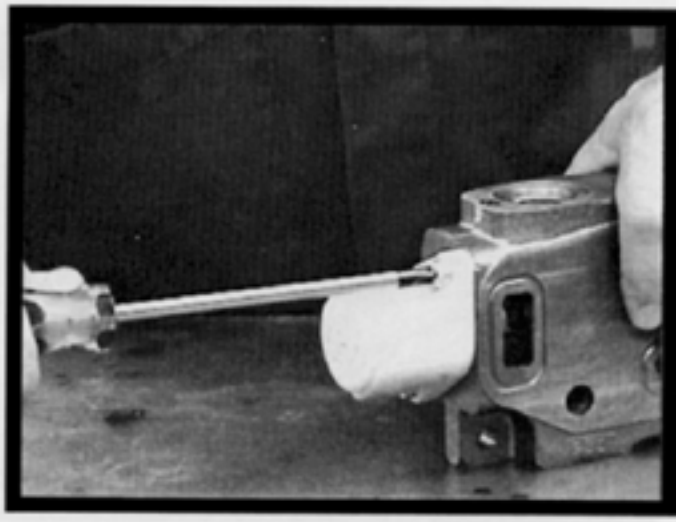
Step 3 - Section Seals

The inlet, mid-inlet and each parallel work section have four, section seals, (Fig. 1, items 1 & 2) on the downstream, mating face. Series work sections and the VA/VG35 split flow mid-inlets have three section seals on the downstream mating face, (Fig. 1, items 1 & 3.) These section seals should be removed and discarded.



REMINDER: ALL WORK MUST BE PERFORMED IN A CLEAN AREA.

Valve Disassembly Instructions



Step 4 - Valve Back Cap

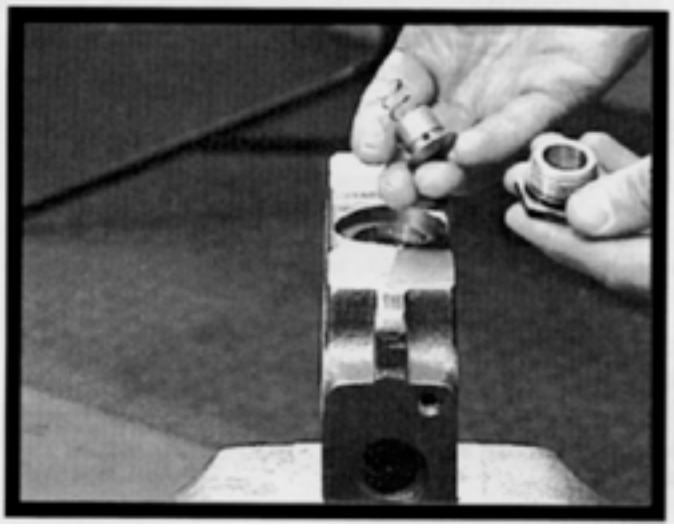
Using a large, Phillips-head screwdriver, remove the two, cap screws (Fig. 1, item 4) which fasten the back cap to the work section. Lightly tap the end of the screwdriver handle with a hammer to break adhesive. Remove the back cap (Fig. 1, item 5).

Step 5 - Control Spool and Seals

Grasp the spring end of the spool with a clean, lint-free cloth and pull the spool out of the housing using a twisting motion. Generally, the rear, retainer plate (Fig. 1, item 6) back-up ring (Fig. 1, item 7) and spool seal (Fig. 1, item 8) will come out with the spool.

CAUTION: For detented spool models, be careful not to remove the detent poppet sleeve (Fig. 2, item 17) unless it is to be serviced.

Using a large, Phillips-head screwdriver, remove the two, retainer-plate screws (Fig. 1, item 9) from the spool clevis end of the work section. Lightly tap the end of the screwdriver handle with a hammer to break the adhesive. Remove the two, retainer plates (Fig. 1, item 6) the back-up ring (Fig. 1, item 7) and the spool seal (Fig. 1, item 8). Tag or mark with the appropriate work section identification number. (See Step 1.) Spool seals (Fig. 1, item 8) and back-up rings (Fig. 1, item 7) should be discarded.



Step 6 - Transition Check

The transition check is located in the bottom center of the work section housing. Carefully clamp the work section in a vise with ports down. Do not clamp on the machined surface. Remove the check-valve cap (Fig. 1, item 10) and its O-ring seal (Fig. 1, item 11). Discard the seal. Remove the check spring (Fig. 1, item 12.) and the check-valve poppet (Fig. 1, item 13).

NOTE: Only cylinder work sections (ports blocked in neutral) have a transition check. Motor sections have only a cap plug.

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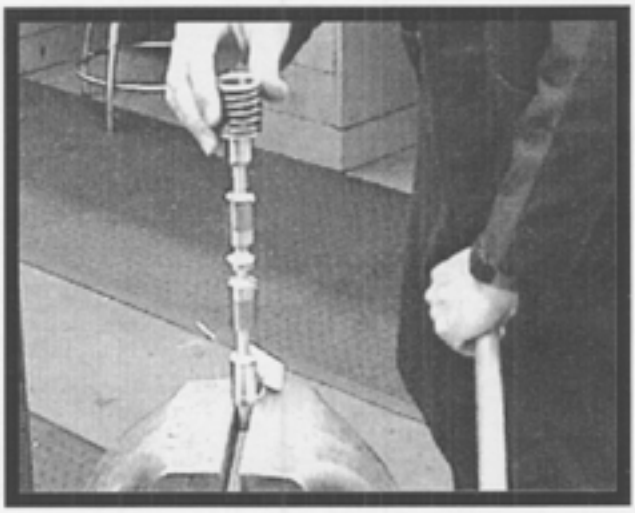
6

Valve Disassembly Instructions

Spool Disassembly

Spring Centered Spool

The spring assembly should not be removed from the spool unless these parts need to be replaced. Once the spool is free of the work section housing, it must be handled carefully to avoid damage. Place the spool vertically in a soft-jawed vise, clamping on the flat spool sleeve, and remove the stripper bolt (Fig. 1, item 14) with a wrench.



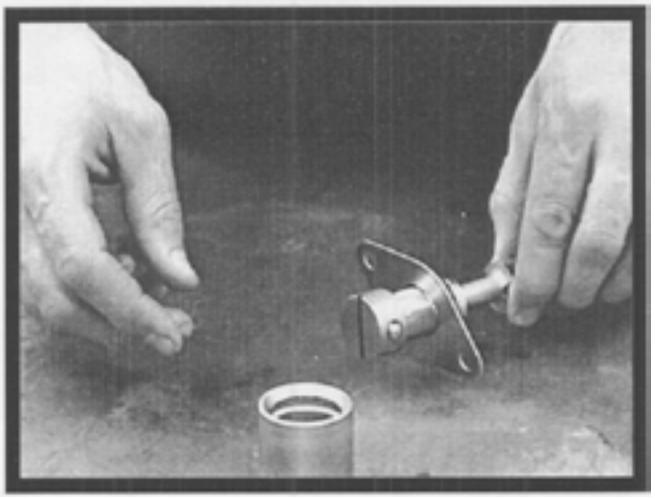
Lightly tap the stripper bolt with a hammer and a punch to help break the adhesive. Cautious application of heat may be required to free the stripper bolt, since an anaerobic thread adhesive was used during its assembly.

CAUTION: Too much heat may distort the spool.

As the stripper-bolt threads disengage, the spring (Fig 2, item 15) and spring guides (Fig. 2, item 16) will release abruptly from the spool.

Detent Spool

The detent assembly should not be removed from the spool unless these parts need to be replaced. Wrap the detent sleeve (Fig. 2, item 17) with a clean, lint-free cloth. Grip the cloth-covered sleeve and pull firmly. As the sleeve moves backwards, the detent balls (Fig. 2, item 18) and the detent spring (Fig. 2, item 19) will release abruptly. The cloth should capture these parts and prevent their loss.



Next, clamp the spool in a soft-jawed vise and remove the detent poppet retainer (Fig. 2, item 20). Place an undersized bar through the detent ball bore to serve as a wrench. Lightly tap the detent poppet retainer with a hammer and a punch to help break the adhesive. Cautious application of heat may be required again, since an anaerobic adhesive was also used in the detent retainer assembly.

CAUTION: Too much heat may distort the spool!

CLEANING, INSPECTION, AND REPAIR

1. Inspect the spool bore, transition check seat and spool from each section for deep scratches, gouges or excessive wear. If any of these conditions exist, replace the section. Minor, surface damage on the control spool and check poppet can be carefully polished away with a very fine, cotton cloth.

2. Examine the machined surfaces of the valve housing for nicks and burrs that could cause leakage between sections. Lightly stone these surfaces to remove any rough spots.

CAUTION: A shallow-milled relief area extends across the O-ring face of the valve housing. This should not be stoned or ground off!

3. Wash all parts thoroughly in a cleaning solvent and blow dry before beginning reassembly. Pay special attention to the number and letters marked on the parts in Step 1. If any marks are removed during cleaning, re-mark immediately.

4. Clean adhesive from threads of spool, stripper bolt, housing, cap screws and hex nut with Loctite™ Chisel Gasket Remover.

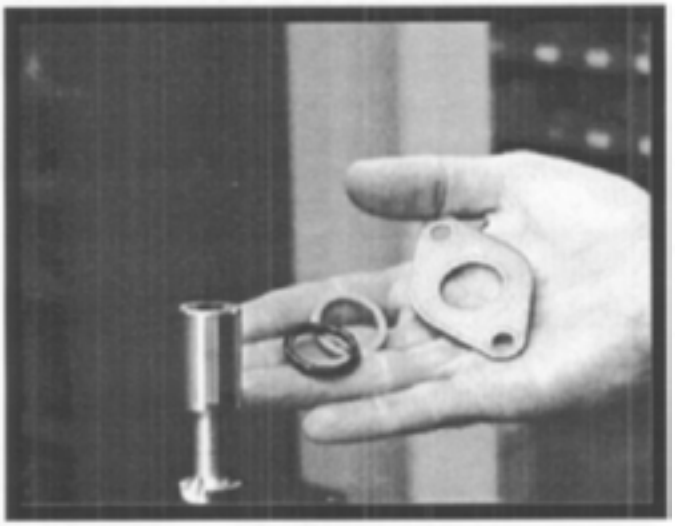
Valve Assembly Instructions

Preparation of Parts

Spray the threads of the new stripper bolt (Fig. 2, item 14) tapped-threaded spool end, all screws and screw holes on both ends of the housing with LOCQUIC Primer Grade NF™ and let dry.

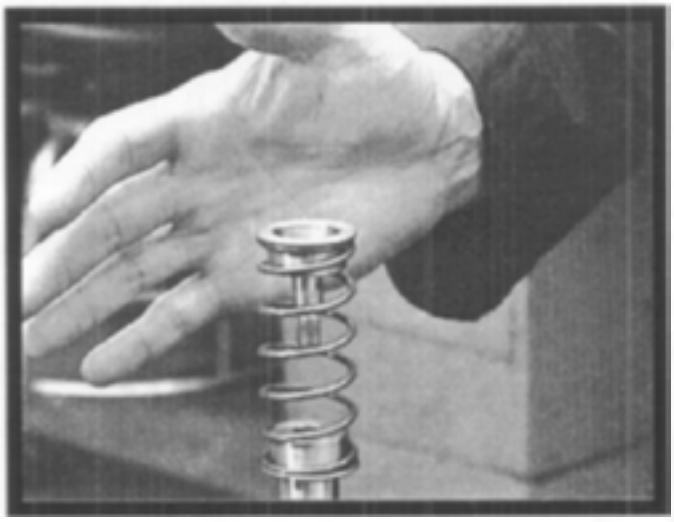
CAUTION: Failure to follow the recommended assembly instructions can result in poor performance or product malfunction. Product should be thoroughly tested to ensure proper operation before the valve is placed back into service.

Spring Center Spool Assembly



Step 1 - Spool Assembly-Spring Centered

Clamp the flat, clevis end of the control spool in a soft jawed vise. Apply Parker Super-O-Lube™ to the spool seal (Fig. 1, item 8.) and slide it onto the end of the spool away from the clevis. Slide on the back up ring (Fig. 1, item 7) and retainer plate (Fig. 1, item 6). Position these items onto the spool, so that they do not interfere with the spool operator mechanism during assembly. Do not allow the O-ring to come in contact with the sharp edge of the spool notches.



Step 2 - Attach Spring Guides and Spring

Apply 2 - 3 drops of Loctite 262™ or equivalent anaerobic adhesive near the middle of the female threads in the spool. Assemble the spring guides (Fig. 2, item 16) centering spring (Fig. 7, item 15.) and stripper bolt (Fig. 2, item 14.) onto the spool (Reverse of Step 7). Torque the stripper bolt to 175 in. lbs +/-4 in. lbs.

CAUTION: Care must be taken to ensure that the spring retainer is not pinched under the shoulder bolt during assembly. This can result in burrs that may cause spool binding. Check for binding by compressing the spring and guides or by rotating the spring guide nearest the housing.

CAUTION: Follow the adhesive manufacturer's instructions for proper cleaning and curing. Failure to clean and prepare parts properly may result in assembly failure!

Lightly coat the centering spring with high- temperature grease to prevent rusting. Set the spool assembly aside and let it cure for a minimum of 1 hour. After curing, test the stripper bolt to make certain it can withstand 125 in. lbs. of breakaway torque.

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8

Valve Assembly Instructions

Detent Spool Assembly

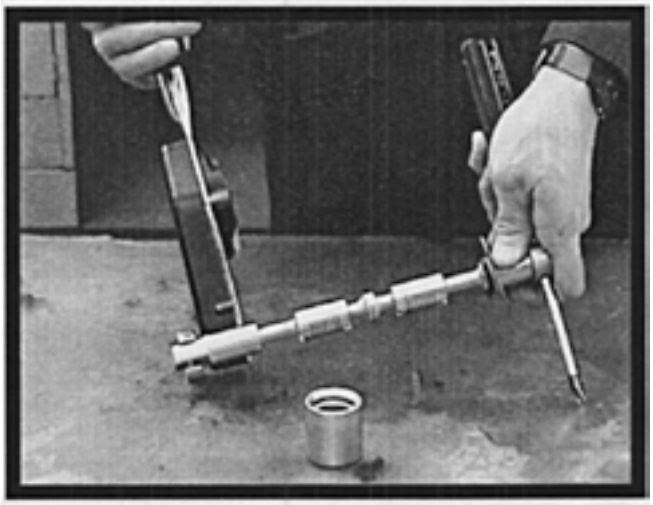
Step 1 - Spool Assembly-Detent

Apply Parker Super-O-Lube™ to the spool seal (Fig. 1, item 8) and slide it onto the spool. Slide the back-up ring (Fig. 1, item 7) and one, retainer plate (Fig. 1 item 6) onto the spool. Position these items onto the spool, so that they do not interfere with the spool operator mechanism during assembly. Do not allow the O-ring to come in contact with the sharp edge of the spool notches. Apply 2 - 3 drops of Loctite 262™ or an equivalent, anaerobic adhesive near the middle of the female threads in the spool.

CAUTION: Follow the adhesive manufacturer's instructions for proper cleaning and curing. Failure to clean and prepare parts properly may result in assembly failure.

Step 2 - Spool Assembly-Detent

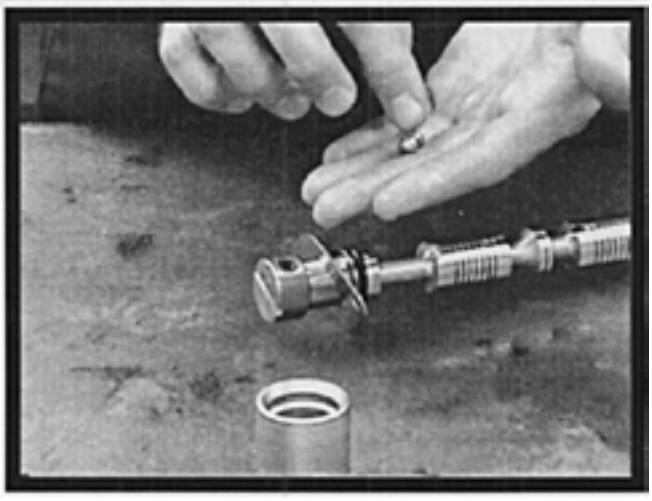
Thread the detent ball retainer (Fig. 2, item 20) into the spool end. Torque the detent ball retainer to 175 in. lbs. +/-4 in. lbs.. This can be accomplished by using a crows-foot socket on the flats of the clevis, and holding the spool by inserting a round, steel rod or screwdriver through the hole in the ball retainer.



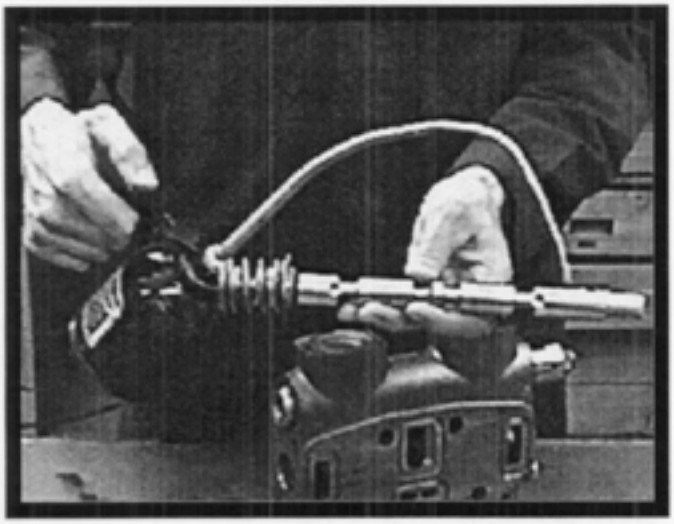
Step 3 - Detent Balls and Spring

Next, lightly coat the detent balls (Fig. 2, item 19) detent spring (Fig. 2, item 19) and entire inside diameter of the detent sleeve (Fig. 2, item 17) with high-temperature grease.

Insert the detent spring into the through hole in the detent ball retainer. Place the steel balls on the ends of the spring. Compress the balls and spring, then slip on the detent sleeve. (Note: The detent sleeve is not symmetrical; one end of the sleeve has a lead-in chamfer. This chamfer must face the spool clevis when assembled.) Move the detent sleeve to the neutral or middle position to prevent the subassembly from separating during subsequent steps.



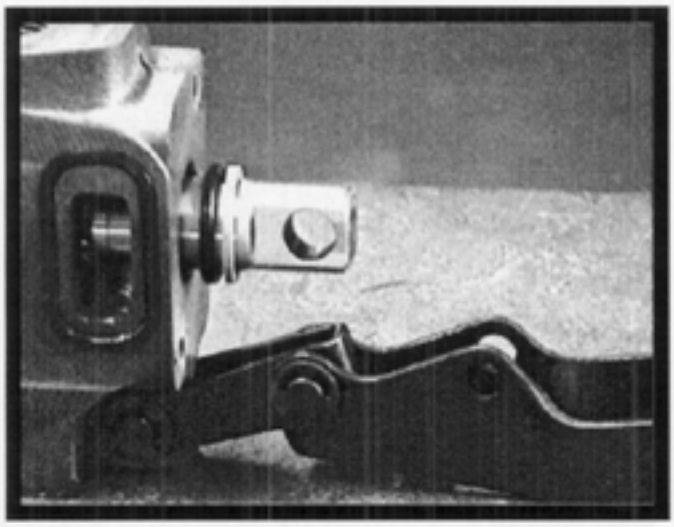
Valve Assembly Instructions



Step 1 - Spool Subassembly

Apply 2 - 3 drops of Loctite 262™ or equivalent to the fillister screw holes in both ends of the housing.

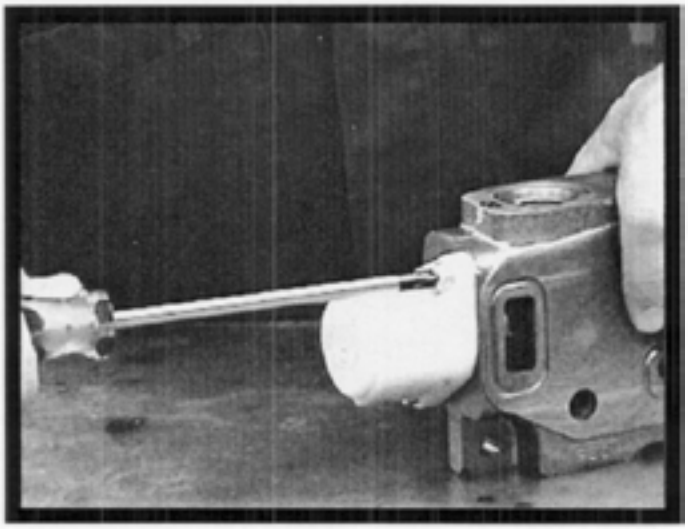
Apply a light coating of clean, hydraulic oil to the valve spool. Carefully insert the spool assembly into the housing. Use caution to avoid causing burrs. Be careful not to pinch, roll or damage the seals. Make sure that the spool and housing are in the proper orientation (see Step 1, page 6 disassembly).



Step 2 - Spool Seal and Back up

Apply Parker Super-O-Lube™ to the spool seal (Fig. 1, item 8) and slide it onto the spool. Slide on the back-up ring (Fig. 1, item 7). Push both items into the counter-bore until they bottom out.

Assemble the two, front, retainer plates (Fig. 1, item 6) using the two short, fillister screws (Fig. 1, item 9). Check retainer plates for proper alignment. Tighten to a final torque of 34 in. lbs. +/- 2 in. lbs.



Step 3 - Back cap

Install the back cap using the two, long, fillister screws (Fig. 1, item 4). Tighten to a final torque of 34 in. lbs. +/- 2 in. lbs.

Caution: Excessive torque will damage the back cap ears!

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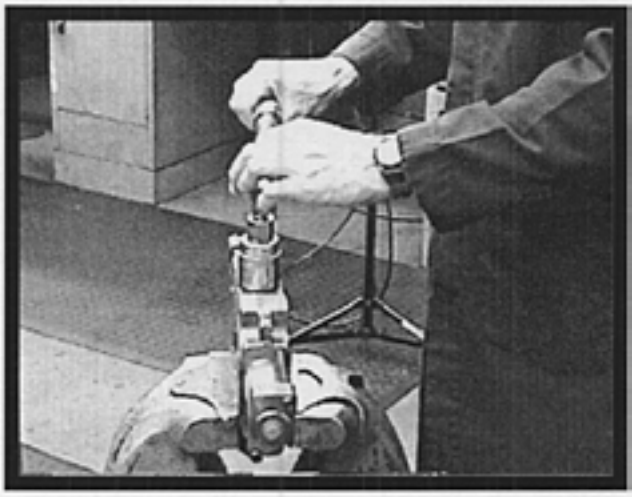
Valve Assembly Instructions

Step 4 - Install Transition Check

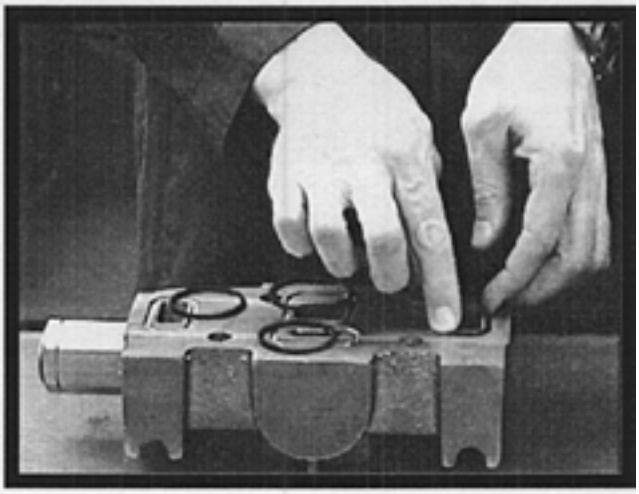
Inspect transition check components for cleanliness. Install check poppet (Fig. 1, item 13) into the transition check cavity. Align the check spring (Fig. 1, item 12) square to the poppet, then carefully place the check cap (Fig. 1, item 11) over the poppet and spring. Turning by hand, engage several threads. Tighten to a final torque of 75 ft. lbs. +/- 5 ft. lbs.



Step 5 - Relief Valves

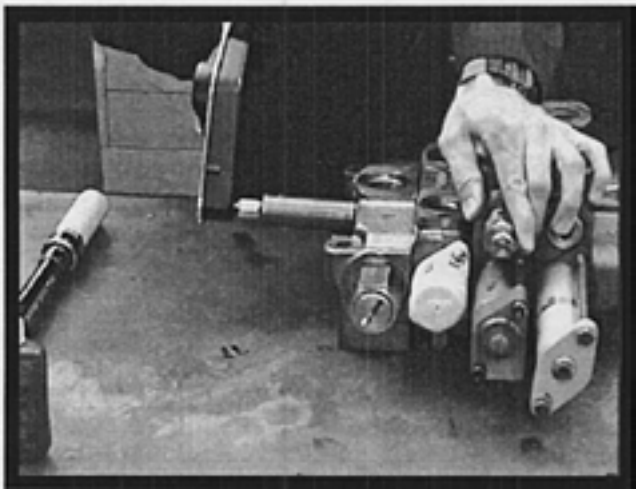
Return all relief valves to their proper positions and torque to 75 ft. lbs.

Install new, section seals. Place section seals (Fig. 1, items 1 & 2, or items 1 & 3) in the proper grooves. Make certain seals stay in their grooves during assembly.



Step 6 - Install Tie Bolts

Slide the tie bolts through the inlet casing. If cap screws are used, place a washer on the cap screw prior to installation. Place the valve sections on the tie bolts in their proper sequence (see Step 1, page 4). Turning by hand, engage several threads in the outlet. If it is a VG series assembly, assemble nut and washer to either end of the stud and follow above instructions. Torque the tie bolts in a cross-corner pattern.



Tie Bolt Torque Values
VA20 - 29 ft. lbs. (348 in. lbs.)
VG20 - 42 ft. lbs. (504 in. lbs.)
VA35 - 34 ft. lbs. (408 in. lbs.)
VG35 - 75 ft. lbs. (900 in. lbs.)
VG60 - 150 ft. lbs. (1800 in. lbs.)

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Troubleshooting

TROUBLE	PROBABLE CAUSE	REMEDY
Oil leaks between sections	Pinched, blown or missing section seal	Replace section seal
	Stud fasteners not correctly torqued	Replace section seals and re-torque
	Mounting plate not level	Loosen mounting bolts and shim as required
	Contamination/burrs on seal	Clean seal groove, replace section seal
Oil leaks at either end of spool	Over-pressurized tank core	Correct high, back-pressure condition
	Worn or damaged spool seals	Replace seals and seal retainers
Spring - centered spools do not return to neutral	Broken centering spring	Replace centering spring
	Misalignment of operating linkage	Check linkage for mechanical binding
	Foreign particles in system	Clean valve and system
Load will not hold	Cylinder leaking or worn	Check cylinder - repair
	Port relief valve not holding	Remove and clean or replace
	Spool or housing scored or worn excessively	Replace section
Load drops when spool moved from neutral	Dirt or foreign particles lodged between check-valve poppet and seat	Disassemble, clean & reassemble
	Scored or sticking check-valve poppet	Replace poppet
No motion, slow, or erratic system operation	Worn pump	Check flow & pressure
	Defective cylinder or motor	Repair or replace
	Low-reservoir oil level	Add oil to specifications
	Clogged suction strainer	Clean or replace
	Suction line restricted	Check lines
	Relief valve not properly set	Check pressure setting
	Relief valve poppet or seat scored & sticking open	Replace relief valve
	Valve spool not shifted to full stroke	Check spool linkage travel

MCCOY MOVING GLOBAL ENERGY FORWARD | DRILLING & COMPLETIONS

Pilot-to-open, spring biased closed, unbalanced poppet logic element

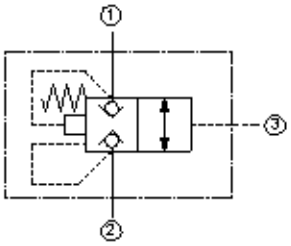
Capacity:
60 gpm (240 L/min.)

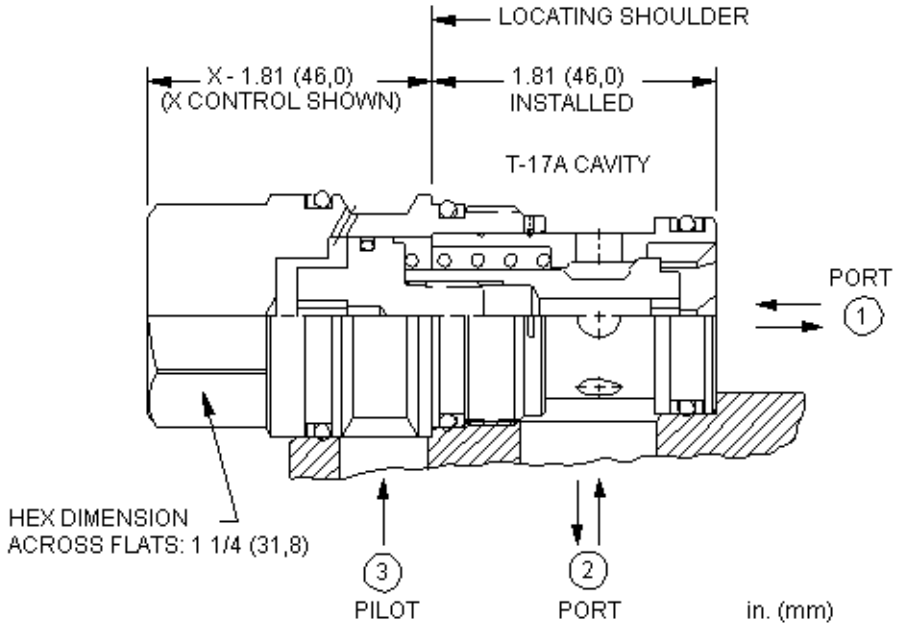
Functional Group:
Products : Cartridges : Corrosion Resistant : Logic Element : Unbalanced Poppet, Pilot-to-open, Switching Element, Spring biased closed, External Pilot Port 3 pilot source

Model:
LKHC

Product Description

These unbalanced poppet, logic valves are 2-way switching elements that are spring-biased closed. Pressure at either work port 1 or 2 will further bias the valve to the closed position while pressure at port 3 will tend to open it. The force generated at port 3 must be greater than the sum of the forces acting at port 1 and port 2 plus the spring force for the valve to open. NOTE: The pilot area (port 3) is 1.8 times the area at port 1 and 2.25 times the area at port 2.





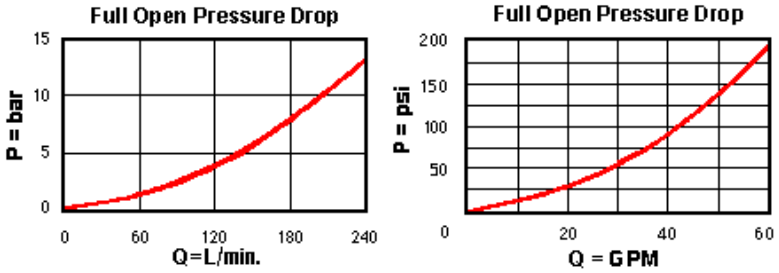
Technical Features

- Because these valves are unbalanced, operation is pressure dependent. Opening and closing of the poppet are functions of the force balances on three areas: 1) Port 1 = 100%, Port 2 = 80%, and Port 3 = 180%.
- These valves are pressure responsive at all three ports, therefore it is essential to consider all aspects of system operation through a complete cycle. Pressure changes at any one port may cause a valve to switch from a closed to an open position, or vice versa. All possible pressure changes in the complete circuit must be considered to assure a safe, functional system design.

- These valves have positive seals between port 3 and port 2.
- Incorporates the Sun floating style construction to eliminate the effects of internal parts binding due to excessive installation torque and/or cavity/cartridge machining variations.
- Stainless steel cartridge options P or W are intended for use within corrosive environments with all external components manufactured in stainless steel or titanium. Internal working components remain the same as the standard valves.

Technical Data

	U.S. Units	Metric Units
Cavity	T-17A	
Capacity	60	240 L/min.
Area Ratio, A3 to A1	1.8:1	
Area Ratio, A3 to A2	2.25:1	
Maximum Operating Pressure	5000	350 bar
Maximum Valve Leakage at 110 SUS (24 cSt)	10	10 drops/min.@70 bar
Pilot Volume Displacement	.15	2,5 cc
Series (from Cavity)	3	
U.S. Patent #	4,795,129	
Valve Hex Size	1 1/4	31,8 mm
Valve Installation Torque	150 - 160	200 - 215 Nm
Seal Kits	Buna: 990-017-007	
Seal Kits	Viton: 990-017-006	



Option Selection

LKHC-X D N

Preferred Options

Control	*Cracking Pressure*	*External Material/Seal Material*

Standard Options

X Not Adjustable

N Buna-N
V Viton

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Pilot operated, balanced piston relief valve

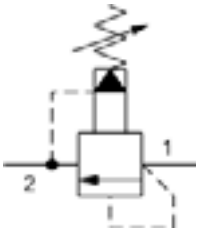
Capacity:
25 gpm (95 L/min.)

Functional Group:
Products : Cartridges : Relief : 2 Port : Pilot Operated, Balanced Piston

Model:
RPEC-LAN

Product Description

Pilot-operated, balanced-piston relief cartridges are normally closed pressure regulating valves. When the pressure at the inlet (port 1) reaches the valve setting, the valve starts to open to tank (port 2), throttling flow to regulate the pressure. These valves are accurate, have low pressure rise vs. flow, they are smooth and quiet, and are moderately fast.



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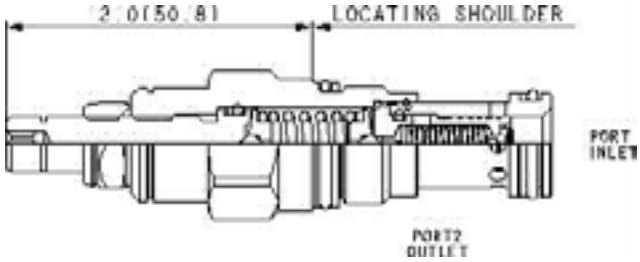


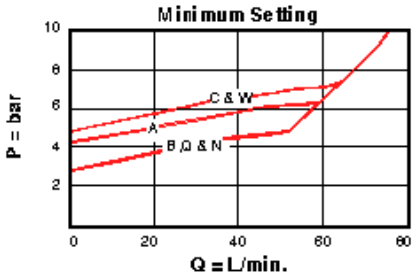
Technical Features

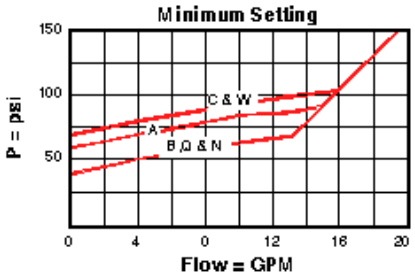
- Will accept maximum pressure at port 2; suitable for use in cross port relief circuits. If used in cross port relief circuits, consider spool leakage.
- Not suitable for use in load holding applications due to spool leakage.
- All 2-port relief cartridges (except pilot reliefs) are physically and functionally interchangeable (same flow path, same cavity for a given frame size).
- Incorporates the Sun floating style construction to minimize the possibility of internal parts binding due to excessive installation torque and/or cavity/cartridge machining variations.
- Main stage orifice is protected by a 150 micron stainless steel screen.
- Back pressure on the tank port (port 2) is directly additive to the valve setting at a 1:1 ratio.
- Stainless steel cartridge options P or W are intended for use within corrosive environments with all external components manufactured in stainless steel or titanium. Internal working components remain the same as the standard valves.

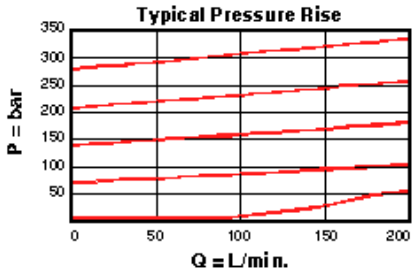
Technical Data

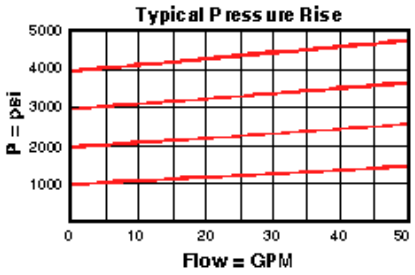
	U.S. Units	Metric Units
Model Weight	0.30 lb.	0.14 kg.
Cavity	T-10A	
Capacity	25 gpm	95 L/min.
Adjustment - Number of Clockwise Turns to Increase Setting	5	
Factory Pressure Settings Established at	4 gpm	15 L/min.
Maximum Operating Pressure	5000 psi	350 bar

Maximum Valve Leakage at 110 SUS (24 cSt)	2 in³/min.@1000 psi	30 cc/min.@70 bar
Response Time - Typical	10 ms	
Series (from Cavity)	Series 1	
Valve Hex Size	7/8 in.	22,2 mm
Valve Installation Torque	30 - 35 lbf ft	45 - 50 Nm
Adjustment Screw Hex Socket Size	5/32 in.	4 mm
Adjustment Nut Hex Size	9/16 in.	15 mm
Adjustment Nut Torque	108 lbf in.	12 Nm
Seal Kits	Buna: 990-010-007	
Seal Kits	Viton: 990-010-006	









RPEC-LAN

Control	Adjustment Range	External Material / Seal Material
Preferred Options		
L Standard Screw Adjustment	**A** 100 - 3000 psi (7 - 210 bar), 1000 psi (70 bar) Standard Setting **W** 150 - 4500 psi (10,5 - 315 bar), 1000 psi (70 bar) Standard Setting	**N** Buna-N
Standard Options		
C* Tamper Resistant - Factory Set **F** Hex Head Screw with Locknut	**B** 50 - 1500 psi (3,5 - 105 bar), 1000 psi (70 bar) Standard Setting **C** 150 - 6000 psi (10,5 - 420	**P** Stainless/Buna-N **V** Viton **W** Stainless/Viton

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K Handknob

O Handknob with Panel Mount

bar), 1000 psi (70 bar) Standard Setting

N 60 - 800 psi (4 - 55 bar), 400 psi (30 bar) Standard Setting

Q 60 - 400 psi (4 - 25 bar), 200 psi (14 bar) Standard Setting

If the material/seal is P, the control must be L or C
If the material/seal is W, the control must be L or C

* Special Setting required, specify at time of order

Related Models

RPEC8

- Explanation of Sun cartridge control options - US units.
- Explanation of Sun cartridge control options - metric units.
- Two-piece, floating cartridge construction.

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